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Annual Report for the Year 1933.

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THE TEA RESEARCH INSTITUTE OF CEYLON,
VICTORIA COMMEMORATION BUILDINGS, KANDY.

The Tea Research Institute of Ceylon.

BOARD OF CONTROL.

(A) Representing the Planters' Association of Ceylon:—

(1) Mr. R. G. Coombe

(2) Mr. Jas. Forbes, (Jnr.) (Chairman),

(3) Mr. A. G. Baynham, M.C.

(B) Representing the Ceylon Estates Proprietary Association:—

(4) Mr. D. T. Richards.

(5) Major J. W. Oldfield, M.C., C.M.G., O.B.E. (on leave).
Mr. J. C. Kelly, (Acting).

(6) Mr. I. L. Cameron.

(C) Representing the Low-Country Products' Association:—

(7) Colonel T. G. W. Jayewardene, V. D.

(D) Representing the Small-Holders:—

(8) Mr. D. H. Kotalawala, M.S.C.

(E) Ex-Officio Members:—

(9) The Hon. the Financial Secretary.

(10) The Director of Agriculture.

(11) The Chairman, Planters' Association of Ceylon.

(12) Chairman, Ceylon Estates Proprietary Association.

Secretary, Mr. A. W. L. Turner, Victoria Commemoration Buildings, Kandy.

EIGHTH ANNUAL REPORT

OF THE

BOARD OF THE TEA RESEARCH INSTITUTE OF CEYLON

FOR 1933.

Foundation:—The Institute was established and the Board of Management incorporated by Ordinance No. 12 of 1925, dated the 27th October, 1925.

Past Chairmen of the Institute.

Name	Date of Appointment	Date of Resignation.
Major J. W. Oldfield, C.M.G., O.B.E., M.C.	7th January, 1926	24th November, 1926
John Horsfall, Esq.	24th November, 1926	14th April, 1927
R. G. Coombe, Esq.	14th April, 1927	9th April, 1929
Major J. W. Oldfield, C.M.G., O.B.E., M.C.	9th April, 1929	30th September, 192[illegible]
C. Huntley-Wilkinson, Esq.	30th September, 1929	28th November, 192[illegible]
R. G. Coombe, Esq.	29th November, 1929	7th April, 193[illegible]
G. K. Stewart, Esq. M.S.C.	7th April, 1932	26th November, 1932
R. G. Coombe, Esq.	26th November, 1932	13th January, 1934
Jas. Forbes (Jnr.), Esq.	13th January, 1934	

Board of Management:—On the 1st January, 1933, the Board of Management consisted of the following Members :—

Ex-Officio Members.

The Hon'ble the Financial Secretary, (Sir Wilfrid Woods, C.M.G.)
The Director of Agriculture, (Dr. W. Youngman, D.Sc., Ph.D.)
The Chairman, Planters' Association of Ceylon, (Mr. A. G. Baynham)
The Chairman, C.E.P.A., (Mr. G. K. Stewart, M.S.C.)

Representatives of the Planters' Association of Ceylon.

Mr. R. G. Coombe.
Mr. John Horsfall.
Mr. Jas. Forbes (Jnr.)

Representatives of the Ceylon Estates Proprietary Association.

Major J. W. Oldfield, C.M.G., O.B.E., M.C.
Mr. I. L. Cameron.
Mr. R. D. Morrison.

Representative of the Low-Country Products Association.

Col. T. G. Jayewardene, V.D., M.S.C.

Representative of the Small-Holders.

Mr. D. H. Kotalawala, M.S.C.

Chairman :—Mr. R. G. Coombe.

Secretary :—Mr. A. W. L. Turner.

Mr. A. G. Baynham retired from the Chair of the Planters' Association of Ceylon on the 10th March, and was succeeded by Mr. B. M. Selwyn.

Major J. W. Oldfield, C.M.G., O.B.E., M.C., proceeded on furlough in April and Mr. D. T. Richards was nominated by the Ceylon Estates Proprietary Association to act for him.

Mr. John Horsfall proceeded on furlough as from the 6th June to the end of October, and Mr. Gordon Pyper was nominated by the Planters' Association of Ceylon to act during his absence.

Mr. R. D. Morrison resigned his seat on the 28th July, and the Ceylon Estates Proprietary Association nominated Mr. D. T. Richards in his place and Mr. J. C. Kelly to act for Major J. W. Oldfield.

Mr. G. K. Stewart resigned the Chairmanship of the Ceylon Estates Proprietary Association on the 3rd August, and Mr. C. E. Hawes succeeded him.

Mr. Jas. Forbes (Jnr.) one of the Representatives of the Planters' Association of Ceylon having completed his three years' term of office retired on the 3rd December and was re-nominated by that Association for a further period of three years as from that date.

Mr. D. T. Richards proceeded on three months' leave as from the 20th December, and the Ceylon Estates Proprietary Association nominated Mr. F. A. Bond to act for him during his absence.

AUDITORS.

Messrs. Ford, Rhodes, Thornton & Company continued to be the Institute's Auditors.

MEETINGS OF THE BOARD OF THE T. R. I.

The Board of Management held 4 Meetings—2 in Colombo, 1 in Kandy, and 1 at St. Coombs Estate. The average attendance was 9 members.

COMMITTEES.

Experimental Sub-Committee Personnel:—The Director, T. R. I., the Chairman, T. R. I.. the Visiting Agent of St. Coombs, the Superintendent of St. Coombs, Messrs. Jas. Forbes (Jnr.), John Horsfall, D. T. Richards, L. C. A. Leefe (acting for Mr. R. H. Horne), I. L. Cameron, C. H. Wilkinson, and the Agricultural Chemist (Convener).

This Sub-Committee met on six occasions.

Finance Sub-Committee Personnel:—The Chairman, T. R. I., the Chairman, Planters' Association of Ceylon, the Chairman, Ceylon Estates Proprietary Association, Messrs. R. D. Morrison, John Horsfall and J. C. Kelly (acting for Major J. W. Oldfield).

This Sub-Committee met on two occasions.

Small-Holders' Sub-Committee Personnel:—The Director, T. R. I., the Director of Agriculture, Col. T. G. Jayewardene, Mr. D. H. Kotalawala, and Dr. C. H. Gadd.

Re-organisation Sub-Committee:—This Sub-Committee was appointed on the 14th April, to consider a scheme of re-organisation and its recommendations were adopted by the Board at a Meeting on the 30th May.

Personnel:—The Director, T. R. I., Messrs. I. L. Cameron and Jas. Forbes (Jnr.).

This Sub-Committee met on three occasions.

STAFF OF THE T. R. I.

Senior Scientific Staff: *The Director, T. R. I.*—Dr. Roland V. Norris proceeded on 8½ months' leave as from the 8th February to the 23rd October and Dr. C. H. Gadd was appointed to act for him. During Dr. Gadd's absence through illness, Mr. Eden acted as Director.

Mycologist:—Dr. C. H. Gadd proceeded on 10 months, 8 days furlough as from the 13th December to the 22nd October, 1934. The Board has decided to renew this officer's agreement for a further period of five years as from the 1st July, 1934.

Biochemist:—Dr. D. I. Evans resigned his appointment as from the 30th June. He proceeded on 11 weeks' leave on the 5th April, prior to retirement.

Entomologist: *Mr. C. B. R. King*:—Owing to ill-health this officer was granted three months' privilege leave as from the 17th April. He resumed his duties on the 17th July.

Tea Technologist: *Mr. J. Lamb.*—The Board at its Meeting held on the 2nd December made the above appointment. Mr. Lamb will take up his duties early in 1934.

Levy on Salaries of the Senior Scientific Staff:—During 1933 the Senior Scientific Staff salaries were subjected to a voluntary levy of 10 per cent. At the Meeting of the Board held on the 2nd December, it was decided that this levy be removed as from 1st January, 1934.

TEA CESS.

Ordinance No. 12 of 1925 provided for an Export Duty of 10 cents per 100 lbs. of tea exported. In 1930 this was found to be insufficient and the Cess was accordingly increased to 14 cents per 100 lbs. for a period of three years from the 1st January, 1931 to the 31st December, 1933. During the year under review the Tea (Control of Export) Ordinance was passed and the Institute's income from the Cess was therefore considerably reduced. The State Council considered the question on the 13th December, and decided that the 14 cents Cess be continued for a further period of one year, *i.e.* until the 31st December, 1934. The matter will come up for further consideration during the ensuing year with a view to its being placed on a more permanent basis.

CONFERENCES.

The Third Conference of the Institute:—was held at the Institute's Laboratories at St. Coombs Estate, on the 27th January, and was well attended. A full report of the proceedings is contained in the *Tea Quarterly* Vol. VI, Part I.

Second Conference of Tea Buyers, Brokers, etc.:—With a view to keeping the Scientific Staff of the Institute fully informed of market requirements, a Second Conference was held in Colombo on the 3rd February. At this Conference Representatives of Agency Firms, Buyers, Brokers, Planters and Officers of the Scientific Staff of the Institute were present.

The question of closer liaison between Blenders, Distributors and producers of tea is now receiving the consideration of both the Ceylon Estates Proprietary Association and the Institute.

SMALL-HOLDERS.

During the year under review the Small-Holdings Officer held 17 Meetings of Small-Holders. Four were in Yati-Nuwara, one in Ulapane and the other twelve meetings in Uda-Palata and Uda-Nuwara. Meetings were followed by demonstration work which has been carried out on 53 holdings. The average attendance at these Meetings was always over 15 Small-holders. 108 Holdings were visited during the year,

A party of 24 Small-Holders visited St. Coombs in September. They were shewn round the different experimental fields and the laboratory.

EMPIRE MARKETING BOARD.

At the beginning of the year the Institute received the balance due on the grant of £1000-0-0 sanctioned by the Empire Marketing Board for the purchase of small-scale machinery. A report on the working of this machinery was sent them on the 28th March.

THE TEA RESEARCH INSTITUTES OF JAVA.

Mr. G. K. Stewart visited Java and obtained general information in regard to the Tea Research Institutes in Java. This information has proved of considerable interest and value to the Institute in Ceylon.

TEA RESTRICTION.

The Tea (Control of Export) Ordinance No. 11 of 1933, came into operation in April. The Institute has been granted exemption from the provisions of the Ordinance.

TESTING OF PLANT AND SYSTEMS OF MANUFACTURE AT ST. COOMBS ESTATE.

The following new rules in respect of the testing of plant and systems of manufacture at St. Coombs, supersede those published in the Institute's Annual Report of 1930 (Bulletin No. 5):—

1. On receipt of such applications, the firm or individual concerned shall be requested to give facilities to the Institute Staff to visit a factory in which such plant or process is being worked and to take such observations as may seem necessary in order to assess the scope and value of the process. Such preliminary data will, of course, be confidential and not for publication.

2. The Institute Staff will then report to the Experimental Sub-Committee who will consider the application in detail and make a recommendation to the Board as to whether the proposals should be entertained or not.

3. The capital cost of installing any such plant shall be met by the firm or individual desiring the test to be carried out and the plant shall be removed by the firm or individual as and when requested by the Director. The firm or individual shall also bear the cost, if any, of restoring that particular part of the factory to its original condition.

4. In regard to all such work, the Institute will retain full liberty to publish in the *Tea Quarterly* or Institute's Bulletins all data obtained whether favourable or otherwise.

5. In installing any such experimental plant, it would seem desirable to obtain a certificate from the firm or individual concerned that the installation as carried out meets their requirements in providing proper facilities for an adequate trial.

PUBLICATIONS.

The Publications of the Institute will be sent, free of charge, to all Superintendents and Assistant Superintendents of Ceylon Tea Estates over 10 acres in extent, and to Estate Agencies dealing with Ceylon Tea, if they register their names and addresses with the Secretary, Tea Research Institute of Ceylon, Victoria Commemoration Buildings, Kandy.

Other persons can obtain the Publications of the Institute on application to the Secretary, the subscription being Rs. 15/- per annum for persons resident in Ceylon or India, and £1-5-0 for those resident elsewhere. In the case of Indian cheques four annas could be added to cover commission.

Single numbers of the *Tea Quarterly* and Bulletins can be obtained at the rate of Rs. 2-50 or 4 shillings per copy.

During the year, the Institute issued Bulletin No. 10 and *Tea Quarterly* Volume VI, Parts 1 to 4.

The undermentioned Publications are out of print:—

Bulletins Nos. 2, 3 and 5.

Tea Quarterly Volume I, Parts 1 to 4.
,, ,, ,, II, Parts 1 and 2.
,, ,, ,, IV, Parts 1 and 2.
,, ,, ,, V, Part 1.

ST. COOMBS ESTATE.

Visiting Agent:—Mr. J. W. Ferguson.

Superintendent:—Mr. John A. Rogers.

A comparison between St. Coombs prices and the Colombo Market average for high grown teas is shewn on the graph at the end of this Report.

A copy of the Visiting Agent's Review on the work done on St. Coombs during the year is attached.

FINANCE.

The Audited Statement of Accounts and Balance Sheet for the year 1933 are included at the end of this Report.

A. W. L. TURNER,
Secretary.

REPORT

ON

ST. COOMBS ESTATE

FOR THE YEAR 1933.

Superintendent:—Mr. John A. Rogers.

Climate:—Season 1933 so far as weather was concerned, was a record for rainfall, and the number of days on which rain fell.

Rainfall 1933. 132·70 inches. No. of wet days 249.

Rainfall 1932. 79·91 inches. No. of wet days 218.

Crop:—Estimate	1933.	128,000 lbs.	Made Tea.
Secured	1933.	132,292 lbs.	do
Secured	1932.	126,644 lbs.	do
Increase		5,648 lbs.	do

The yield per acre on the old acreage was 736 lbs.
The 1926-28 clearing, 57 acres, yield per acre was 138 lbs.

Cost of Production:—

Revenue Account, Estimated 47·69 cents. Actual Cost 47·13 cents.

Capital Account, Estimated 10·62 cents. Actual Cost 10·43 cents.

Crop Sales:—*Colombo.* Nett Average for 1933. 68·53 cents.
Nett Average for 1932. 62·00 cents.

Old Clearing 1926-28, 57 acres:—It was decided to cut out all poor jât bushes on the clearing and as a result 15,254 bushes were removed and the clearing replanted with plants from our own nurseries. In addition 8,701 plants were put out to other vacancies.

The 1931 clearing, 28¼ acres, was supplied and the number of plants required was 7,609.

1932 clearing, 9½ acres, was also supplied, and plants put out amounted to 5,412.

Both the 1931 and 1932 Clearings were forked twice during the year with Artificial Mixture and all available Green Manure.

1931 Clearing was pruned in May and three methods were adopted.

(1) A Block pruned to 2 inches above Stump Level,

(2) B Block pruned to 3 inches above Ground Level.

(3) C Block pruned to 4 inches above Ground Level.

B Block received a second treatment in November, side branches left at the last pruning and gourmandisers were cut back.

The Scientific Staff have plots on this clearing receiving similar treatment and records of progress will be collected.

Cultivation of the Old Tea:—Inorganic Mixtures were used throughout the year, and it has been decided to continue this policy during 1934. No change in the general appearance of the tea was noticeable. Artificial Mixtures were applied 4, 14 and 24 months after pruning.

Nurseries:—The Nurseries are well-stocked with Tea Plants, some 91,144 of which will be used for supplying in 1934. Any balance over may be sold as there will be no clearings opened at present.

Green Manure:—Everything is being done to increase the planting of all varieties of Green Manure. The only difficulty experienced is the control of weeds in the Ravines where Green Manure is planted. .

Machinery and Buildings:—These are all in good order.

General:—Weather conditions were bad during most of the year under review, but still a great amount of work was done, and on the whole good progress has been made.

The Superintendent goes on furlough after 5 years of good work.

J. W. FERGUSON.

REPORT

OF

THE DIRECTOR,

TEA RESEARCH INSTITUTE OF CEYLON

FOR 1933.

The year under review has again been one of difficulty, largely due to uncertainties regarding the financial position. Considerable interruption to the work of the Institute was, moreover, caused by an unusual incidence of illness amongst the Senior Staff. With the exception of the Director, who was on home leave, every member of the Senior Scientific Staff was incapacitated by illness at one time or other during the year. In the case of the Entomologist and the Mycologist such illness was of a serious nature necessitating absence from work for considerable periods.

The Director was on leave from the 8th February to the 23rd October, during which period Dr. Gadd officiated.

Dr. D. I. Evans, Biochemist, resigned his appointment as from the 30th June, and left Ceylon on April 5th on leave prior to retirement. Owing to the financial position it was not considered advisable to fill the vacancy immediately and it was not, in fact, until late in December that an appointment could be made. Mr. J. Lamb, the officer then selected, is due to arrive in Ceylon early in the new year. Pending Mr. Lamb's arrival the Agricultural Chemist has been in charge of the Biochemical Division in addition to his own duties.

Amongst the Junior Staff, the services of Mr. K. M. Goonatillake, Temporary Assistant on Nettle Grub work, were discontinued from 31st May, as a measure of economy.

Finances:—The Institute's receipts are derived solely from the export Cess and from the profit on St. Coombs Estate. The imposition of restriction as from 1st April, 1933, and the consequent reduction in tea exports, naturally resulted in a material falling off in the yield of the cess which amounted to Rs. 304,939 as against Rs. 354,543 in 1932, a decrease of Rs. 49,504.

In regard to St. Coombs Estate, the Institute was exempted from restriction of its own crop and the latter realised 132,292 pounds as against an estimate of 128,000 lbs. Reasonably good prices were obtained during the first two months of the year though these were not so high as in previous years. The market then collapsed and prices as low as 48 cents were obtained in May. Thereafter, with the exception of a slight setback in September, conditions steadily improved and the nett average for the year was 68·53 cents as compared with 62·00 cents in 1932.

Every possible economy was made in estate working with the result that there was a profit on the year of Rs. 30,053. It will not, however, be possible to maintain working costs at the present figure and unless high grown teas show a greater improvement in price than at present seems probable it cannot be expected that such a favourable margin will be obtained in 1934. Similar economies were effected in the expenditure of the Research side, while a voluntary salary cut of 10 per cent. in the case of the Senior Staff and 5 per cent. in the case of the Assistant Entomologist was also imposed.

The Institute was further faced with the situation that the cess, under the terms of the Ordinance, was due to be reduced to 10 cents as from 1st January, 1934. At this rate the yield for 1934 would amount to Rs. 218,513 only, a further decrease in income of Rs. 86,426. It was immediately obvious that in such circumstances the work of the Institute could not be maintained on its present basis. A Sub-Committee was therefore appointed by the Board to examine the future financial position and to make recommendations.

As a result of this investigation it was decided to apply to Government for the cess to be retained at its present figure of 14 cents while, in order to reduce recurring expenditure, it was further decided to make a reduction in the Senior Scientific Staff by the non-renewal of the Entomologist's agreement in 1934. In view of the many important entomological problems which have to be faced the intention is, however, that this post should be restored as soon as funds permit.

These proposals received the unanimous support of the Ceylon Association in London, the Ceylon Estates Proprietary Association and the Planters' Association of Ceylon and came before the State Council in December. It was then agreed to maintain the 14 cents rate for one year, 1934, with the tacit understanding, however, that the matter would be further considered during that year.

This decision has placed the Institute in a very awkward position. It is obviously impossible for a systematic and well arranged programme of work to be arranged unless the probable receipts for at least three or four years ahead are known. Field experiments, once instituted, must be

continued for a period of years in order that reliable results may be obtained, and in the matter of staff also agreements for at least five years have to be made. It is therefore the intention of the Board to bring up the matter again early in 1934 and press for a more permanent arrangement.

Buildings:—No additions were made to the Institute's buiidings during the year. The question of accommodation for the Junior Staff is, however, acute and this matter will receive priority in respect of any capital expenditure that can be afforded during 1934.

Visitors' Day:—Representations having been made that the *first* Wednesday in the month is inconvenient to many planters, Visitors' Day has now been changed to the *last* Wednesday. In the case of persons who may wish to visit on other days it is requested that, if possible, appointments should be made. Members of the Staff are frequently away on visits to estates and, unless an appointment be made, disappointment may be caused owing to the absence of the officer it is desired to meet.

Library:—Dr. Gadd remained in charge of the Library which has now been placed on a thoroughly sound basis in regard to classification and arrangement. The number of periodicals and reprints obtained by exchange with other institutions is steadily increasing and further shelving accommodation will soon be required. Planters and other persons interested are at liberty to make use of the library, though books and periodicals cannot be removed from St. Coombs.

Publications:—One bulletin was issued during the year in addition to *The Tea Quarterly*. The demand for the Institute's publications continues to increase and a sum of Rs. 4,103 was received in subscriptions from persons not entitled to a free issue. Rs. 1,849 was also received for advertising space in *The Tea Quarterly*. With these receipts the publications were self-supporting.

Advisory Work:—In contrast to the previous year there was some falling off in the number of enquiries dealt with, these amounting to 1,600 as compared with 2,000 in 1932. The decrease was almost entirely in regard to manufacturing problems and was no doubt partly due to the fact that Dr. Evans' services were no longer available after April. The chief reason, however, was probably the marked improvement in tea prices which occurred after the middle of the year and which relieved the immediate anxieties of many low-country estates. There was for similar reasons a reduction in the number of visits paid to estates by members of the staff which amounted to 142 as against 245 in 1933. This was, however, partly due to touring being interrupted at various times by illness amongst the staff. The above figures do not include visits to small-holdings made by the Small-Holdings Officer.

Pests and Diseases:—Considering the abnormally wet season it is somewhat surprising but highly satisfactory to note that diseases of tea have not been unduly prominent. Cercosporella, which might have been expected to be prevalent under the conditions obtaining has not been more severe than usual.

Amongst leaf diseases, a disease resembling Brown Blight, but caused by a hitherto unrecorded species of Sphaerulina, was observed on one estate. The fungus was isolated and the disease transmitted in the laboratory through inoculation of wounds. It seems likely, however, that in the field infection may occur by other methods. Collection and burning of the affected leaves will keep the disease in check.

In the Low-country Thread Blights have been somewhat prevalent and it is likely that these are encouraged by the practice of cut-across pruning in which the centre of the bush is not cleaned up. These diseases normally disappear when fine dry weather sets in, but in all probability their incidence would be materially reduced by the adoption of rim-lung pruning which permits of the removal of infected shoots. At low elevations true Branch Canker—to be distinguished from wood rot—appears to be of increasing importance and attention is directed to the report of the Mycologist dealing with this subject.

Considerable attention has been paid to the subject of Witches Broom which in the opinion of many persons is becoming much more prevalent. In this connection, however, there is probably a certain amount of confusion. Accumulated evidence points more and more to the conclusion that the term "Witches Broom" is applied to a variety of symptoms which may arise from very different causes. The term is analogous to the medical term "fever" which describes the *condition* of the patient but which is by no means of a specific character. Many specimens sent in to the laboratory as Witches Broom cases are not really so and it is, therefore, likely that the increase in incidence is not really as great as sometimes supposed. In spite of such a reservation it must be admitted, however, that on certain estates the "disease" is spreading and is of considerable importance. As has been already pointed out in *The Tea Quarterly* there is a considerable resemblance in many respects between the symptoms of Witches Broom and those of the disease known as Tea Yellows in Nyasaland. Investigation of the latter disease has shown quite clearly that it is produced by a deficiency of sulphur in the soil and can be cured by remedying this condition.

Experiments have, therefore, been carried out by the Mycologist during the past year to see whether Witches Broom is due to a similar cause. Full details will be found in the report of the Mycologist and it need only be said here that the results obtained indicate that the two diseases are

evidently not identical in so much as sulphur treatment has had no beneficial effect on Witches Broom. The specific cause therefore remains obscure. It seems probable, however, that similar symptoms may sometimes arise from such diverse causes as severe wood rot, the very slow attack of a root disease, or the presence of slab rock in the soil or even from adverse climatic conditions as was seen in Kandapola district. In the latter case the conditions cleared up quickly when normal weather was experienced.

Insect pests have not caused undue trouble during the year. There was a general decrease in the intensity of Tortrix attacks though the number of attacks in Uva was greater than usual. Elsewhere the persistently wet weather no doubt helped to keep the pest in check.

Work on the Tortrix egg parasite, *Trichogramma*, was continued. Most of the difficulties in the large-scale breeding of this parasite have been overcome except the question of cost. Unfortunately this last factor seems likely to be decisive, more particularly as preliminary field trials with the parasite have shown that under the conditions so far experienced its efficiency is low.

There was again a decrease in the area attacked by Nettle Grub, the largest acreage reported in any one month (July) being 1,243. Badulla was the worst area, followed by Passara. Wilt is probably the main natural controlling factor, while under artificial measures soap spraying is the most convenient on account of its relatively low cost. Nicotine is more effective but is far too expensive. The chief requirement at present, however, is a more efficient type of spraying machine and attention is being directed to this problem.

Bagworms have been frequently reported and in nearly all cases seem to be associated with Albizzias from which they migrate to the tea.

Field Experiments:—In addition to work at St. Coombs, field experiments have been continued at Peradeniya, Galatura and Passara and the thanks of the Institute are due to the authorities concerned for the facilities provided. At the end of the year a further area on Gonakelle Estate was placed at our disposal on which additional manurial experiments are being laid down. The necessity for economy in estate work imposed by the conditions of the last two years has been reflected in the number of enquiries which have been received in regard to manurial practice. In the Annual Report for 1932 the view was expressed that but little risk attached to the use of the cheaper inorganic nitrogenous manures in place of organics, provided these were used in reasonable quantities and combined with a liberal use of green manures. This view was based on the results of the manurial trials laid down at St. Coombs which had then been in progress

for two years. The third year of this experiment, completing the first pruning cycle, has confirmed in every way the findings already recorded. Once more no significant difference in yield has resulted when comparing the effect of Blood Meal, Ammonium Sulphate and Cyanamide, nor has any difference in quality been noticeable between the teas treated with organic and inorganic nitrogen respectively. As in the two previous years no effect has been produced by the addition of potash.

The experiment is to be continued but the results already obtained, extending as they do over three years, give a very clear answer to enquiries as to the relative effects of organic and inorganic nitrogen.

There is little evidence, in short, that manures, *when applied in reasonable quantities,* have any effect on quality and this applies just as much to inorganic manures as to organics.

On the other hand, there is every reason to believe that unduly high nitrogenous manuring of any type, resulting in a sudden forcing of growth, is detrimental to quality; in other words the decisive factor is the *amount* of nitrogen applied and not its kind.

It is necessary to emphasise this point in view of possible developments. With improving economic conditions, more funds will undoubtedly be available for manurial programmes. On many estates cessation or drastic limitation of manuring has already been reflected in reduced yields. This state of affairs cannot be immediately remedied and any attempt to restore yields too rapidly by heavy manuring is likely to be attended with very definite risks. Should such attempts be made, however, recourse will no doubt be had to inorganic fertilisers on account of their relative cheapness. If bad results follow, these will be attributed, quite unfairly, to the use of inorganics as such and the old prejudice against these is likely to be revived. This would be most unfortunate as inorganic fertilisers, properly used, can make an important contribution to economical working.

The manurial experiment at St. Coombs is confined to the influence of nitrogen and potash. In the extension of this experment at Passara phosphate reactions will also be investigated and the comparison between inorganics and organics will be carried a stage further.

Pruning experiments, in which different types of pruning are under comparison, have been continued at St. Coombs, Peradeniya and Galatura. Full discussion of the results, more particularly with regard to yield figures, will be deferred till next year when a full pruning cycle will have been completed. In regard to other factors, however, certain striking results have already emerged, more particularly in the low-country experiments. The main point is, perhaps, the very definite indication, already briefly referred to in the Annual Report for 1932, of the great advantages resulting

from the use of rim lung pruning at low elevations. The later results show that at Galatura rim lung pruning, when compared against a clean prune, has reduced the number of deaths after pruning by no less than eighty-seven per cent., while, in addition, the amount of pre-tipping dieback was reduced by nearly half.

The fear is sometimes expressed that the presence of lungs on the bush at low elevations may slow down the production of new shoots in the pruned portion. Experience shows, however, that the exact opposite occurs, the weight of tippings obtained from plots on which six lungs were left being more than double that from cleaned pruned plots.

The basic fact behind these results is a simple one, namely that any treatment which leaves a reasonable amount of leaf on the bush at pruning enables the bush to continue its manufacture of food supplies and, hence, recovery is not dependent solely on the food reserves which, as is well known, are often quite inadequate in the low-country. The importance of lighter forms of pruning at low elevations has been stressed ever since Gadd's work showed the relationship between food reserves and recovery, and a cut-across is now frequently employed. This, however, not infrequently leaves much less leaf on the bush than might be expected and for this reason is less efficacious than a rim lung prune. A cut-across has the further disadvantage that the centre of the bush cannot be properly cleaned out, weak and unhealthy wood is left and the plant is rendered more liable to diseases of various kinds.

Full details of these most interesting experiments will be found in the report of the Plant Physiologist to which reference should be made. Their importance may be gauged from the fact that, even ignoring the loss of crop resulting from dieback, the capital value of the bushes saved by the adoption of rim lung pruning has worked out to more than Rs. 70 per acre.

The introduction of restriction and the necessity for reducing crop has brought along its own problems. Amongst those which are receiving attention are (1) the effect of variations in the length of plucking rounds and (2) the effect of resting after pruning. The experiments have only been in progress a brief period and all that can be said at the moment is that crop has been considerably reduced by the longer plucking round.

It may be mentioned that in these, as in all other major field experiments, the experimental leaf is being manufactured on the small-scale plant, so that the effect of treatment on quality as well as on yield can be observed.

Experiments on the establishment of green manures and cover crops have been continued by the Agricultural Chemist. Amongst less well known species *Cassia leschenaultiana* and *Indigofera arrecta* show promise while

Cassia tora, Crotalaria juncea and *Tephrosia noctiflora* must be considered failures, at any rate under St. Coombs conditions. *Crotalaria semperflorens* also seems unsuitable on account of its liability to severe attack by caterpillars.

In last year's report favourable mention was made of *Parochetus communis*. Further experience of this low cover shows that it has the disadvantage of dying back in the dry weather and though it seeds freely and re-establishes itself, this takes time, with the result that the ground is left bare and unprotected at a period when thunder showers are frequent. Its utility against erosion is thereby somewhat reduced.

Trials are meantime being made with *Trifolium subterraneum* which in root system is intermediate in character between species such as *Indigofera endecaphylla* and shallow rooted species such as *Parochetus*. Fuller details of these and other varieties tried will be found in the report of the Agricultural Chemist.

Physiological Investigations:—In addition to major field experiments to which reference has already been made, the Plant Physiologist has had under investigation the effect of planting methods on the subsequent growth of the plant, while different methods of vegetative propagation of tea have also been studied. Layering, propagation by cuttings, stooling, division, grafting and inarching have all been examined. Of these the last method has perhaps been the most promising.

Investigations have also been made in regard to the variability of tea seedlings and on transpiration. The latter is of importance not only in respect to the general physiological processes of the plant but also in considering the loss of water from the pluck during withering. Details will be found in Mr. Tubbs' report.

Soils:—Owing to the fact that the Agricultural Chemist was for a large part of the year in charge of biochemical and factory experiments in addition to his own duties, no new major lines of investigation could be initiated. Some attention has, however, been paid to the question of manganese in soils. This element is required in small quantities by plants but is toxic when in excess. Several cases have occurred where unhealthy tea has been associated with a relatively high manganese content in the soil as compared with neighbouring areas where the tea was doing well. Manganese appears to be readily taken up by the plant and accumulates in the leaves where it possibly plays a part in the activity of the oxidising enzymes which are of such importance in manufacture. With excess of manganese, however, leaf fall occurs together with necrosis of the buds and younger portions of the stem.

Tea Manufacture:—The resignation of Dr. Evans and the absence of the Director on leave left the Institute without a Biochemist from April till the end of the year. During this period the work of the Biochemical section was therefore under the direction of the Agricultural Chemist, but in the circumstances there had naturally to be a considerable restriction in the work carried out.

Amongst the many enquiries relating to manufacture firing problems were the most numerous and 1819 samples of tea were received for moisture determinations. Of these many were connected with tests of dryer performances. A very large number, however, were purely routine control analyses to see if teas were properly fired. There would appear to be no real reason why such determinations should not be carried out for themselves by estates. A simple and inexpensive apparatus for this purpose has been put on the market (vide *The Tea Quarterly*, Vol. 5, page 60) and the actual operations involved present no difficulty.

That the necessity exists for such control is clearly indicated by the large number of tea samples received in which the moisture content is excessive. Many of such samples have been final fired and it does not appear to be sufficiently realised that final firing at low temperatures and with a rapid passage of the tea through the dryer often has but a negligible effect on the moisture content.

A certain number of complaints have been received in regard to the deterioration of tea during transit to London and the subject has received some ventilation in the Press in which various theories have been put forward. Without for a moment excluding all other causes it is the considered view of the Institute, based on data received in a good many cases of such fading out, that in the large majority at any rate of these cases deterioration has been the result of the teas being despatched with a too high moisture content and rectification of this defect has usually put matters right.

A good deal of time has been spent on the standardisation of the Institute's small-scale machinery. This is of importance as this plant is used for the manufacture of leaf from the experimental plots and the comparisons made will obviously suffer in value unless the different machines in use are strictly comparable in action.

This work is being extended to the commercial plant and, in particular, the question of roller pressures is being examined. It is fair to say that little is really known about the pressures actually exerted in rolling under different conditions. The terms "hard" and "light" rolling have little real significance and further information is urgently required in regard to the work actually done in rolling. Interesting results have already been obtained, details of which will be found in the report of the Agricultural

Chemist. The work promises to have important developments and should throw much light on the relative performances of different types of rollers, different battens, etc. while it is hoped it may also open up an approach to the investigation of roller temperatures.

Mention here must be made of the great amount of help the Institute has received from Colombo brokers in examining and reporting on experimental tea samples. In the absence of chemical criteria of quality we are absolutely dependent on such assistance in order that the effect of different experimental treatments may be assessed and our difficulties would have been greatly increased but for the help so freely given.

Small-Holdings:—The Small-Holdings Officer during the year visited 108 small-holdings and carried out demonstrations on 53 of these. Repeated visits were paid to each village and every effort made to see that methods recommended were actually adopted. Improved methods of cultivation and pruning have been demonstrated and the usefulness of green manures and cover crops stressed. In addition to demonstrations, meetings of small-holders have been held when tea cultivation in all its aspects has been discussed.

When restriction was first imposed there was some fear that the position of small-holdings would be seriously prejudiced, coupons being freely sold and the holdings neglected. Speaking generally, however, this has not proved to be the case. On the contrary holdings have received more attention than formerly and the position of the small-holder has been considerably improved.

Conferences:—The Third Conference of the Tea Research Institute was held at St. Coombs on January 27th, 1933, and was attended by nearly two hundred planters. A full report of the proceedings will be found in *The Tea Quarterly,* 1933, Volume VI, page 1 *et seq.*

A conference was also held in Colombo between representatives of Agency Firms, Buyers and Brokers and officers of the Scientific Staff. The question of closer liaison between the Institute and market interests is receiving further attention.

Acknowledgments:—In addition to acknowledments already made we have as usual to record appreciation of the co-operation and hospitality extended by so many planters in every district. The facilities provided at Galatura and Gonakelle Estates have been continued and our cordial thanks are due to the owners, agents and superintendents concerned. The Director of Agriculture and his Staff have co-operated in the pruning experiment at Peradeniya and in many other directions and Mr. J. W. Ferguson, Visiting Agent, and Mr. F. J. Whitehead, Consulting Engineer, have as always placed their time and experience freely at the disposal of the Staff.

This report cannot be concluded without reference to the pending retirement from the Chairmanship of the Board of Mr. R. G. Coombe. The time, trouble and enthusiasm which Mr. Coombe has devoted to the work of the Institute can only be fully appreciated by those closely connected with its adminstration and so far as the Scientific Staff are concerned it is a pleasure to record their most cordial appreciation of the consideration and support he has extended to them throughout his long period of office.

The reports of the Scientific Officers are appended.

ROLAND V. NORRIS,
Director.

REPORT OF THE MYCOLOGIST FOR 1933.

Advisory:—305 letters have been received in this Division and 306 despatched. 103 consignments of diseased plants were received for examination and report, of which 91 were tea. The remainder consisted of miscellaneous green manure plants and shade trees commonly grown on estates.

Leaf Diseases:—The usual common diseases Grey Blight, Brown Blight and *Phoma theicola* have been normally prevalent, but despite the abnormally wet season Cercosporella was not unduly prominent.

In August, specimens were received from one estate which closely resembled a marginal attack by Brown Blight. A microscopic examination revealed the presence not only of Brown Blight (*Colletotrichum camelliae*) but also of a species of Sphaerulina which has not previously been recorded. Later, the same fungus was found on the leaves of tea bushes growing under very heavy shade provided by fruit trees.

The attack is normally on the margin of the leaf though infection sometimes occurs nearer the mid rib. The infected area is of a red-brown colour, not zoned and somewhat brighter than areas attacked by brown blight. Perithecia occur on both sides of the leaf, thinly scattered over the diseased area, partly erumpent, black and ovoid in shape. The asci are cylindrical to clavate, 69-78 × 10-12 microns, 8 spored; spores ovate elliptic, 17-20 × 6 microns, hyaline, 3-septate.

This species of Sphaerulina was taken into pure culture successfully and inoculation experiments have been carried out to determine its virulence. So far successful inoculations have been obtained through wounds. Field observations, however, indicate that under certain circumstances infection may occur without the medium of a wound. The collection and destruction of the affected leaves will keep the disease in check. A careful watch will be kept for the further occurrence of this disease.

Thread blights including *Rhizoctonia solani* have been rather more prominent this year in the Low-country. In their manner of attack they are somewhat similar, in that the fungus grows up the stem either as distinct white cords (white thread blight) or as an almost invisible weft (Rhizoctonia). The main evidence of attack is to be found on the leaves as the fungus spreads fanwise over them and causes their death. The leaves fall but many remain attached to the bush hanging by almost invisible threads.

The abnormal wet weather has no doubt favoured the incidence of these diseases but it is also probable that the diseases are also favoured by the cut across method of pruning. For their optimum growth these fungi require damp shady conditions; fine dry weather always effectively checks the disease and the bushes recover. It is advisable to prune the

patches of tea affected by these diseases by the 'rim lung' method which allows of the cleaning of the frame and the removal of many shoots bearing the fungus. After pruning, the bushes should be sprayed with a fungicide such as Bordeaux mixture.

Stem Diseases:—No new stem diseases have been observed during the year. Apart from Wood Rot which is caused by the invasion of wood rotting fungi the frames of Up-country tea bushes are relatively free from disease. Thorny Stem Blight (*Aglaospora aculeata*) has been observed on several occasions during the year. This disease is readily recognised by the presence on the dead branch of small black thorns which can be felt on drawing the finger tips gently over the surface; the wood is brownish, often with short black streaks or flecks. When once a branch is affected the disease progresses down the main stem and frequently results in the death of the bush. The removal of the diseased tissue by pruning is the only efficient remedy.

At lower elevations a true branch canker is becoming of increasing importance. This disease is entirely different from Wood Rot which is frequently termed Branch Canker. The most prominent character of the true branch canker of tea is the development of callus at the edge of what appears to be a longitudinal wound. An examination of the wound, however, discloses the fact that it has not been caused by mechanical means as the bark and cortex remain *in situ* but are dead. Sometimes the dead cortex flakes off disclosing the wood when a typical canker is formed surrounded by apparently healthy callus or healing tissue. Specimens of such cankers have frequently been sent into the laboratory as examples of vigorous healing. Unfortunately, however, the callus rarely unites over the canker but dies back before healing is complete and a second or even a third callus may arise behind the first one.

In other cases the stem appears gnarled or burred owing to an irregular development of callus or gall wood.

These cankers at pruning time should be removed and not left in the bush under the mistaken idea that they are mechanically caused wounds, healing normally. While the bush is in full leaf the cankers are not evident unless they have completely encircled the stems, when the stems above the cankers die completely.

Although the cankers may not cause the death of the attacked shoots they undoubtedly reduce their vitality, so that the stems above the cankered region become more liable to infection by other diseases particularly red rust. Red rust (*Cephaleuros parasiticus*) is a disease of weak bushes, and one of the causes of weakness is frequently the occurrence of branch canker below the rusted areas.

The fungus *Macrophoma theicola,* or its perfect stage *Physalospora neglecta,* is normally associated with the true branch canker of tea in Ceylon, and is regarded as the cause of the disease. Recently another ascomycete was found associated with this disease. It had fusoid spores 40-45 × 8-10 microns, multiseptate, and possibly belonged to the genus Leptosphaeria. Attempts to isolate the fungus failed, however, so inoculation experiments could not be carried out. Another species of Leptosphaeria having spores 12-16 × 3-4 microns, 3 septate, constricted at the septae was found on another specimen.

It will be recognised that the formation of a canker is a late stage of the disease; very little is known concerning the early stages. For this reason the view expressed by Smee and Leach concerning a somewhat similar disease in Nyasaland may be of interest. They maintain that the primary cause of the canker is the injury caused by the tea mosquito bug (*Helopeltis bergrothi*) which allows of the invasion of fungi, stimulates the formation of callus lips and thick woody growth on both sides of the wound, and results in a malformed stem resembling our gnarled form of branch canker. Mosquito blight, however, is not common in Ceylon and there is no correlation between the incidence of mosquito blight and branch canker here. On the other hand, however, there is no conclusive evidence that the fungi constantly associated with the disease are able to invade uninjured tissues. Further investigations are necessary to clear up this point.

Root Diseases:—Further cases of the Armillaria root disease have been recorded this year. In one instance the disease occurred on young Grevillea trees as well as the surrounding tea. The disease however, is by no means common, but where it occurs the removal of all old infected roots is essential if its further spread is to be prevented.

Witches Broom:—It has previously been noted that the disease known as Witches Broom in Ceylon has many symptoms which closely resemble those of the Tea Yellows disease of Nyasaland particularly as regards the general growth of affected bushes. Photographs of affected Nyasaland bushes kindly supplied by Dr. H. H. Storey of the East African Agricultural Research Station, Amani, confirmed this view. The main point on which the disease symptoms differ is the pronounced yellow colour of the leaves of affected bushes in Nyasaland and which is indicated in the popular name of that disease.

The recently published work of Storey and Leach, a review of which was published in *"The Tea Quarterly"*, Vol. VI, pp. 121-127, clearly indicates that the cause of the disease in Nyasaland is a deficiency of

sulphur and that the disease, at least in its early stages, can be cured by the application of sulphur in the form of sulphates. In Ceylon the use of sulphur in a powdered form applied to the soil in which Witches Broom bushes were growing has given very inconsistent results. In some cases marked benefit was obtained whereas in others the effect was negligible. Sulphur tends to make the soil more acid and as tea requires an acid soil for its optimum growth it was considered that where sulphur had a beneficial effect it probably operated by improving the soil reaction.

Witches Broom disease, however, occurs on soils of suitable reaction for tea and in such cases the application of sulphur to the soil has had a negligible effect on the incidence of the disease. The work of Storey and Leach, which provides the first instance of a specific disease of a crop plant with characteristic symptoms as a result of sulphur starvation, indicated the necessity for further experiments on the relationship of sulphur and the Witches Broom disease.

An area of affected tea was selected and divided into 8 plots each containing from 44 to 56 bushes. Four of thsse plots were manured with a mixture (A) comprised of Sulphate of Ammonia, Sulphate of Potash and Safaga Phosphate. The remaining four plots received a mixture (B) of Nitrate of Soda, Muriate of Potash and Safaga Phosphate. The quantities used were such that all plots received nutrient materials at the rate of 40 pounds of Nitrogen, 40 pounds of Potash and 30 pounds of Phosphoric acid per acre and in order to ensure even distribution each bush was manured individually with a measured quantity of manure.

The essential difference between the two manure mixtures as far as this experiment is concerned is that mixture (A) contains sulphur in the form of sulphate, equivalent to 62 pounds per acre whereas mixture (B) contains none. Their nutrient values apart from sulphur are equal so that any improvement exhibited by the plots receiving mixture (A) may be attributed to the effect of sulphur.

The major difficulty in an experiment of this nature is to obtain an accurate estimate of the incidence of the disease at the beginning and end of the experiment. An attempt to overcome this difficulty was made by examining each bush of every plot and ascribing a mark according to the stage of the disease. A healthy bush was indicated by 0; 1 was given to bushes showing the first indications of disease; 2, 3 and 4 were allotted according to the severity of the disease, 4 being given to bushes in the last stage of disease. The bushes were re-examined and again allotted marks three months and fourteen months after the commencement of the experiment.

No marked general improvement was visible in any of the plots at either of the later examinations and this observation is confirmed on examination of the markings. If a diseased bush improved in health it would be evident by smaller marks being allotted; such improvement was not, however, consistently evident in any plot and examples of the opposite effect could be found.

The general effect of the treatments is indicated by the following figures. At the end of the experiments there were in the plots which received the (A) mixture (*i.e.* which includes sulphur) 37 fewer bushes marked sick than at the commencement of the experiment. The corresponding figure for the plots manured with mixture (B) is 36.

The reduction in the number of sick bushes may be due to cures or deaths. The number of bushes lost in the (A) mixture plots was 14 against 19 in the plots receiving (B) mixture. Viewed in that light 23 cures can be ascribed in the (A) plots and 17 in the (B) plots, a difference of 6. It should be noted that where a cure was apparently affected it generally occurred with bushes which received 1 mark only initially; the recovery of more severely attacked bushes was exceptional.

A general measure of the incidence of the disease in each plot may be obtained by dividing the total marks allotted in a plot by the number of bushes in that plot. The mean incidence of the disease in plots (A) at the commencement of the experiment was 1·38, and 0·87 at the end; the improvement is represented by the difference, viz. 0·51. The corresponding figures for the (B) plots were 1·54, 1·09 and 0·45. It is evident from these figures that the improvement in health of those bushes receiving sulphur as compared with those receiving the (B) mixture is so small as to be of no importance, certainly not of economic importance.

Another experiment with the same object was carried out on an infected area in another district. Here again no visible improvement occurred in the bushes which received the fertiliser containing sulphur as compared with those receiving no sulphur.

These experiments show conclusively that the inclusion of sulphur in the manure mixture does not have an appreciable beneficial effect on the incidence of the Witches Broom disease from which it may be inferred that this disease is not the result of a deficiency of sulphur in the soil. I should, however, like to make it clear that these results in no way detract from the work of Storey and Leach referred to earlier. Although Witches Broom disease resembles the Nyasaland "Yellows" in many respects, it is evident that their causes are not fundamentally the same.

The cause of the Witches Broom disease in Ceylon still remains obscure despite the numerous experiments carried out. The experiments have consistently given negative results. It is therefore impossible to make with any confidence recommendations concerning its remedial treatment.

Tea Cider:—Considerable interest in the new beverage termed Tea Cider has been displayed and numerous requests for samples of the ferment have been received locally and from abroad. Cultures have been maintained continuously in the laboratories to meet these demands; full instructions have been issued with all samples despatched. The sale of Tea Cider as an aerated water was at first prohibited in Ceylon by the Excise laws owing to the alcoholic content of the beverage, but the law has now been amended to allow of its sale.

It was to be expected that the beverage would not suit all palates. The usual criticisms of the drink are that it is too sweet or too sour. The sweetness or otherwise is a matter which has to be carefully controlled in the brewing process and these faults can be eliminated by slightly extending or decreasing the time of brewing.

C. H. GADD,

Mycologist.

REPORT OF THE ENTOMOLOGIST FOR 1933.

Staff:—Owing to illness, the Entomologist was absent from duty from February 23rd. to July 18th. For the same reason, Mr. G. D. Austin was away during October.

For economic reasons, the strength was reduced by one in April. Mr. K. H. M. Goonatillake had been employed on the Nettle Grub investigation on a temporary basis for two years, and it is much regretted that this step had to be taken.

Advisory:—498 letters of enquiry were received, dealing with requests for identification of pests and advice. Most of these related to tea. 84 visits were made to estates.

Tortrix:—There was again a decrease in intensity of attack compared with the previous year, but reports from Uva showed that its appearances there were much more numerous than usual. As its presence in Uva has been known for a long time these developments are not to be interpreted as an increased spread, but that circumstances have favoured the appearance of Tortrix, by, perhaps, the temporary decline of controlling factors such as parasites.

On St. Coombs there was a scarcity of eggmasses at the beginning of the year, which was probably a reflection of the phenomenally wet weather which lasted until the end of January, when larval and pupal parasites were unusually numerous. A dry December shows the probability of an increase in eggmass laying early in January, 1934, as parasites are very scarce.

Owing to the dearth of eggmasses early in the year, the egg-parasite experiment could not then be carried out, but it is planned to make another attempt to carry it through, starting on January 4th, 1934.

The following parasites were obtained from the field during the year.

Ichneumonidae

Phytodiaetus capuae Morely.—(common).

2 unidentified.—(fairly common).

Braconidae

Microdus sp.—(not common).

Chalcididae

Brachymeria euploae Westwood.—(very common).

Eulophidae

Tetrastichus sp.—(fairly common).

Trichogrammatidae.

Trichogramma erosicornis Westwood.—(rare).

Moth Eggs for Trichogramma:—The breeding of *Ephestia* moths in meal to which Marmite and Codliver oil were added has considerably improved. Instead of a former moth production of 3-4 per cent. of the eggs put in, it is now 9-10 per cent. Other experiments in technique were made, and at present the following method is practised:—

Preparing the Meal:—A stock meal of ½-oz. each of Marmite and Codliver oil is made up, and 1-oz. of this is mixed with every 5 pounds of sterilised meal (a wheat meal and bran poultry mixture).

Sowing the Eggs:—Used at the rate of 6,000 eggs per lb. of meal, for some time eggs were scattered over the surface of the meal. It was found that this method gave rise to a great congestion of larvae in the top layer of meal. There was an active migration upwards towards the surface of the meal and all these young larvae subsequently died. The migration downwards into the unconsumed meal was hardly apparent then. In consequence of this the eggs were scattered over a thin layer only of meal, the remainder of the meal being added several days later when the caterpillars had hatched and become established. The result of this procedure is that no early migration takes place at all, and no caterpillars that are not full grown leave the meal, which they do to pupate elsewhere in the cage.

Collection of Moths and Eggs:—This is carried out, as usual, by means of a vacuum cleaner directly into the egg deposition jar, which is inverted on a stand over a table, the top of the jar being covered with 25 mesh bolting silk. Each morning the eggs are swept into a 50 mesh sieve, and cleaned of dust and scales by the vacuum from below. The eggs are then put through a 25 mesh sieve, which removes most of the foreign matter, such as the legs of moths.

Nettle Grub:—There was again a decrease in the area affected by these pests. In July 1,243 acres were reported attacked; this was the largest monthly figure for the year, and compares with 1,668 in April, 1932, and 2,052 in April, 1931. The Badulla district was the most favoured by Nettle Grubs, followed by Passara. *Natada nararia* was, as usual, the commonest species.

The following parasites were bred out during the year:—

Parasite	Host.
Braconidae	
Apanteles sp.	*Thosea cervina*
Rhogas sp.	,, ,,
Fornicia ceylonia	*Natada nararia*
Ichneumonidae	
Goryphus variibalteatus Cam.	,, ,,
Hemiteles sp.	,, ,,
Eulophidae	
Euplectrus sp.	,, ,,
Tetrastichus sp.	,, ,,

Ecology:—A series of observations was started in selected places embracing population counts, records of wilt and parasites, and meteorological notes, to endeavour to find out some correlation between the appearances and absences of both Nettle Grubs and their natural enemies.

Control:—The most reliable method of control at present is that afforded by spraying with soap sprays. The present recommendations as to strength are:

Against young larvae (up to 10 days old)	—1-lb.	soap to		10	gallons	water
For the next week or so	—1-lb.	,,	,,	15	,,	,,
Half-grown larvae	—1-lb.	,,	,,	20	,,	,,
Up to full-grown larvae	—1-lb.	,,	,,	30-40	,,	,,

Many insecticides have been tried in addition to soap, many of them somewhat better, among which Nicotine would appear to be the best. Unfortunately, it adds so much to the cost of the solution as to make it quite prohibitive under present conditions. What is wanted is not so much a better spray material as a better machine. Such a machine must be portable, and deliver an atomised spray similar to that from a fly spray, from a jet that can be adjusted to different angles. Experiments have shown, using fly sprayers, that instead of using some 400 gallons of spray per acre, the amount delivered would be considerably less than 10 gallons per acre. This would mean a very great saving both in cost of material and of labour. If in addition the cost of the machine was low, it should be possible to spray 100 acres in a few days instead of taking, as at present, several weeks. A fly sprayer used for the purpose of spraying Nettle Grub has two objections: firstly, it delivers a more or less horizontal jet, whereas an upward one is required, and, secondly, being hand operated it becomes very tiring to use. Therefore, in addition to the characteristics mentioned above, the ideal machine should be automatic in action.

Leeches:—Once more there have been enquiries about leeches (*Haemadipsa zeylanica*). They are very troublesome and difficult to get rid of. Experiments have shown that they are very susceptible to dry conditions and succumb very quickly. Cattle are the chief means of spreading them, so that if their movements are checked, or even prohibited where possible, a great deal can be done without much expenditure. Failing that, there is not much that can be done. Quite small areas could be treated with a decoction of crude tobacco, soap and water, at the rate of a pound of tobacco to six gallons of water, in which is dissolved two ounces of soap. This should only be done in wet weather, when the leeches are in the grass and active. In dry weather it is of no use, since they either die or disappear.

Mites:—Several reports of mites, mainly Yellow Mite, *Tarsonema translucens* Green, have been received this year. As a rule it is not necessary to apply any counter measures against Yellow Mite. It seems to turn up when the bushes are not in a healthy condition owing either to excessive rain or to drought. In either case a return to good growing weather will enable the bushes to shake of the attack, without the necessity of resorting to sulphur dusting.

Bagworms:—Although reports of these pests come in at most times of the year, the most common period seems to be July-August. It is by no means certain how many generations per annum there may be, as different species (and there are nearly a dozen of them) may not be all the same in this respect, but it seems probable that there are not more than two of any importance. According to correspondence received in this office, nearly all cases of bagworm attacking tea are associated with Albizzias, and when the pests are active they migrate to the tea when the Albizzias are either defoliated or lopped, chiefly the latter. In order to avoid the attack being transferred to tea loppings should be examined for bagworms, which, if present, should be collected and destroyed. The only parasites recorded in this laboratory so far are:

Parasite	Host
Eupelmidae	
Anastatoidea brachartonae Graham.	*Psyche vitrea*
Chalcididae	
†*Brachymeria euploae.*	,, ,,
Ichneumonidae	
Mesostenus sp.	*Clania crameri*
Eulophidae	
Sympiesis sp.	,, ,,

†This is the same as the common pupal parasite of Tortrix

Shot-Hole Borer:—Shot-hole borer was found in two estates in Maskeliya not previously reported, so that it has now advanced southwards to Maskeliya village. An examination of estates close by showed that it was very scarce, and it is not probable that it will become of serious importance.

Survey of Experimental Plots:—Since the beginning of 1931 an analysis of 54 manurial experimental plots has been made every fortnight, with the object of discovering whether the various treatments favoured or otherwise any tea pests which might be found on them. The most common pests were Tortrix and Red Spider, but results of the whole series of investigations gave entirely negative results.

Green Manure Pests:—From Dadap (*Erythrina lithosperma* Bl.) was reported the Spotted Locust (*Aularches miliaris*) once.

Shot-Hole Borer was reported from *Grevillea,* and Bagworms from *Albizzia.*

The programme of experimental work for 1934 includes the following :—

(1). Field experiment to determine the rate of spread and efficiency of *Trichogramma* in the eggs of Tea Tortrix.

(2). Laboratory experiments to find the most suitable conditions for breeding *Trichogramma.*

(3). Improvement in technique in raising *Ephestia kuhniella,* including methods of killing the eggs for use with *Trichogramma.*

(4). Continuation of life-history experiments of various pests of tea and green manures.

(5). Continuation of work dealing with the efficiency of soap and other sprays of various species of Nettle Grubs.

(6). Comparative trials of similar spraying machines of different manufacture.

(7). Continuation of ecological studies.

C. B. REDMAN KING,
Entomologist.

REPORT OF THE PLANT PHYSIOLOGIST FOR 1933.

Correspondence:—123 letters were received and 170 letters were despatched, exclusive of yield reports, of which 104 were received.

Visits:—Twenty-two visits to estates were made during the year.

Acting:—On the Mycologist proceeding on leave on December 13th, the Plant Physiologist was placed in acting charge of the department.

Vegetative Propagation:—Tests of various methods of vegetative propagation of tea have been made during the past three years, from which general conclusions as to their relative values may be drawn.

(a) **Layering:**—This method labours under two disadvantages, firstly, rooting is slow, even when ringing is performed between the buried portion and the parent bush, and secondly, the number of layers obtainable from a single bush is limited by the number of branches suitably placed.

(b) **Stooling:**—Shoots from the stool allowed to develop until red wood has formed at the base do not root as readily after earthing up as those whose bases are etiolated at an early stage. It is not, however, advisable to earth up before the buds break, as a reduction in the number of new shoots, accompanied by delay in their production, results. The intensity of this effect appears to depend upon the thickness of the layer of earth above the stool, a very thin layer having a relatively small effect. The new shoots, when well rooted, may be severed from the parent stool and planted out. A large mortality of the rooted shoots when planted in the open has been noted. Better results would probably be obtained by establishing them in baskets under shelter prior to planting out. Experience so far does not suggest that this method is sufficiently rapid.

(c) **Cuttings:**—Hard wood cuttings give very poor results. This is probably due to the slow callusing of mature tea wood, and the relatively low proportion of carbohydrate reserves in the stem. Soft wood cuttings bearing leaves give better results provided they can be maintained free from the attacks of fungi and bacteria until rooted. Tunstall [1] has recently been successful in producing rooted plants from single leaves bearing the axillary bud.

(d) **Division:**—The division of young seedlings into halves has been successfully practised, and a small area of pairs of "twins" has been planted out for experimental use. It is possible to sub-divide further, but the process is difficult and a large proportion of the seedlings may be spoilt. Experience has shown that the use of older, woody seedlings does not give as good results as are obtained from young ones.

(e) **Grafting:**—Grafting with hard wood grafts has not been very successful. The use of younger material has not been tried.

(f) **Inarching**:—This process has been successfully practised on a small scale. The method used is as follows: The plant it is desired to propagate is surrounded with young vigorous seedlings in pots supported in such a way that contact with the central plant can be made in the desired spots. A superficial wound in both scion and stock, about an inch long, is made with a sharp scalpel and the wounded areas adpressed. The scion is secured to the stock by a small length of adhesive tape and is then left undisturbed until they become organically connected. The time required for this depends upon the age of the tissues concerned and the growth of stock and scion. Young green tissues unite far more quickly than "red wood" stems, which in turn unite more rapidly than completely mature stems. This effect of age is most marked, green tissues uniting in ten weeks or more, whereas mature stems may require as many months.

Quick growth of the stock and scion also accelerates the union considerably; the plants should therefore be well established in a compost containing a generous amount of old, well rotted cattle manure before the operation is performed. Four to eight months old seedlings form suitable stocks.

When union has occurred, as may be determined by removing the adhesive tape from one of the plants, the scion is severed from its roots and also just above the first leaf above the point of union. It will be seen that if on a given scion shoot there are five well-formed buds, five inarchings may be performed. The method therefore gives promise of considerable rapidity relative to other methods.

In Figure I the process is illustrated on the right. On the left is a plant in which union between stock has occurred. The scion has been cut off close below the point of union, and also above the first bud. The leaf subtending the bud has been halved to reduce transpiration demands until the scion bud bursts into growth.

In order to avoid confusion arising subsequently between branches produced from the stock and the scion branches, young stocks should be used and the unions made low down on them. If a clean central stem be later maintained to a height of two or three inches above the point of union confusion will not arise.

Alternatively a stock of markedly different leaf characters may be used, *e.g.* a China or low hybrid stock with a large leaved scion and *vice versa*.

The potential value of methods of rapid vegetative multiplication is obvious, and fully justifies the examination of the question. The example of rubber is sufficient, though it must be remembered that in tea the economic use of clones will be dependent on their value in giving enhanced flavour, strength, and quality rather than merely high yields. The practical application of these methods must await suitable methods of selection for

Fig. I.

these desirable points being elucidated. In addition, it should be realised that the advent of a serious fungal or bacterial leaf disease would make the selection and propagation of resistent strains of prime importance

Further expansion of this line of research is at present impracticable, owing to the prior demands of other lines of investigation, but it will not be lost sight of in the event of an expansion of the Institute's activities becoming possible in the future.

The Variability of Tea Seedlings:—The results obtained on this subject have already been discussed, [(2)], but may be summarised here.

The form of a seedling is influenced by its environment; the fertility of the soil, the supply of moisture, and the amount of light, for example, have considerable influence. The environment of a seedling varies considerably from place to place in a seed-bed, and in consequence variations in the form of the seedlings result. In addition the inherited constitution is by no means the same in each seedling.

It is possible, however, to compare the relative importance of environmental differences and of inherited differences as causes of variability.

The differences between the twinned seedlings produced as described above will be due to variations in the local environment of the plant, since they have the same inherited constitution. The differences between pairs of twins will be due both to differences in environment and to differences in constitution, since they are produced from different seeds. The difference between the variation within pairs and the variation between pairs will indicate the importance of the differences in inherited constitution, since if the latter are unimportant the variation will be the same. If they are important, the variation between pairs will be larger than that within pairs.

Seed was obtained from good jât bearers known to be relatively even in type. From these seeds a large number of pairs of twins were obtained, which, after growth in washed sand, were transferred to baskets. Six months after the "twinning" operation the height and number of leaves were measured on one hundred and eighty-seven pairs. The height was taken from the junction of the base of the seed leaf with the stem to the base of the apical bud, plants from which the cotyledon had already dropped being omitted. In counting the leaves, fish leaves were not included.

The following figures are an index of the variability between and within pairs:—

	Height	Leaf Number
Between pairs ...	1·918	4·687
Within pairs ...	0·743	2·251

Statistical test shows that these differences are real, and are not due to chance. Thus the variation between pairs is larger than that within pairs. It may therefore be concluded that differences in inherited constitution do play an important part in producing variations in tea seedlings.

Transpiration :—A seedling tea bush bearing 8·37 grams dry weight of leaves was found over five days to absorb 101·9 c.c. of water. After clean pruning, only 17·8 c.c. of water was absorbed in five days. These figures illustrate the great reduction in water absorption that follows on the removal of the leaf surface of the bush. Even after pruning, however, water is still absorbed to a limited extent, and is lost by evaporation from the cut surfaces and from the bark.

The effect of pruning and defoliation on water uptake were further illustrated by a comparison of the rate of ascent of eosin solution in (a) untouched shoots 75 cms. long, (b) defoliated shoots 75 cms. long and (c) defoliated shoots originally 75 cms. long from which the upper 37·5 cms. had been pruned off. The mean upward movement per hour was found to be: (a) 5·5 cms., (b) 1·0 cms., and (c) 0·0 cm. In the case of young seedlings six months old, whose roots were immersed in eosin solution, no eosin penetrated to the stem in four hours when the leaves and green stem had been cut off, whereas the whole length of the stem of an unpruned plant was permeated by the dye in that time.

It cannot be assumed that the uptake of mineral elements necessarily follows a parallel course to the uptake of water. The effect of pruning on the uptake of mineral elements requires further elucidation.

The loss of water from a plucked shoot, taking place partly *via* the cuticle and partly *via* the stomata, will be influenced by the degree to which the stomata are open or closed. The accurate estimation of the average degree of stomata opening over the whole of a shoot is very difficult but preliminary observations on the changes during the preliminary stages of withering have been made.

The shoots were maintained in a closed atmosphere over an aqueous mixture containing 243 grams of sulphuric acid in 1,000 grams. The mechanical shock of affixing the shoot to the apparatus caused a partial closure of the stomata, followed by reopening. As withering proceeded, the stomata gradually closed again, this process being practically complete by eight hours after plucking, under the conditions of the experiment. Closure does not appear to be continuous, there being indications of a tendency to reopen to a small extent in the fifth hour after plucking. Final closure occurred after a relatively small water loss, and this stage will be normally reached very early in the withering process, in which case the main loss of water during withering must be via the cuticle.

It appears that uniformity of jât may aid in obtaining an even wither, the value of which in manufacture is universally recognised. Flush from "medium" and "low" jât bushes in fields of mixed type was collected, and the amount of water in the leaf after withering for 23 hours determined. It was found that the water content of the low jât was significantly lower than that of the high jât flush at the end of the experiment. It may therefore be expected that flush from a uniform jât will give a more even wither than from a mixed jât.

The thickness of the cuticle, and consequently the resistance to water loss through it, is least in the youngest leaves and greatest in the old leaves. The rate of water loss from the bud, and first and second leaves in atmospheres of varying humidity was examined.

The leaves, separated from the stalk and from one another, were placed in closed vessels over mixtures of water and sulphuric acid in varying proportions. The periodic opening of the vessels for the purpose of determining the water loss of the leaves prevented the humidity of the air being in equilibrium with the mixture below, as is evidenced by the fact that loss occurred from the leaves exposed over water. However, the series A-F (Table I) represents a series of decreasing humidities, although the intervals between different treatments are not equal. The loss of water, expressed as a percentage of the total water in the leaf in each of three twelve hour periods, is shown in Table I, errors due to respiration being neglected.

TABLE I.

		A	B	C	D	E	F	Mean
Gms. H_2SO_4 in 100 gms. mixture.		Nil	33·10	43·75	57·65	84·48	100	—
Mean percentage loss of water per twelve hours.	1st	13·8	49·2	48·7	55·8	55·9	56·4	46·6
	2nd	6·1	23·8	21·7	21·8	22·4	24·2	20·0
	3rd	8·3	15·2	13·9	12·5	13·1	13·2	12·7
Percentage loss in 36 hrs.		28·2	88·2	84·3	90·1	91·4	93·8	79·3

As a whole, the greatest loss of water occurs during the first period, the loss diminishing during subsequent periods as the leaf becomes more fully dried. The loss of water during the total thirty-six hours is influenced, as would be expected, by the humidity of the air surrounding the leaf. The greatest difference occurs between the first pair and suggests that, at a given temperature, decreasing the humidity beyond a certain point will not speed up the rate of wither to an appreciable extent.

Statistical analysis shows that the interaction between humidity and time is significant. Reference to the table shows that dry air results in the loss of more water from the leaf in the early stages of drying than in the later, compared to moist air.

In Table II is shown the percentage loss of water from bud, first, and second leaves.

TABLE II.

		Bud	1st Leaf	2nd Leaf	Mean
Mean percentage loss of water per twelve hours	1st	53·4	47·1	39·6	46·7
	2nd	19·8	19·4	20·8	20·0
	3rd	11·2	12·8	14·1	12·7
Percentage loss in 36 hours		84·4	79·3	74·5	79·4

The bud and leaves do not differ significantly in the total percentage of water lost, but during the first twelve hours there is a significant tendency for the younger tissues to lose water more easily than the old. When the flush is not separated into bud, first and second leaves this will be partially compensated for by an equalising movement of water within the stem and leaves of the flush.

The interaction between time and leaf is significant and indicates that the curves of water loss with time for different leaves are dissimilar, the rate of loss falling more rapidly in the younger tissues than in the older.

The interaction between leaf and humidity is not significant indicating that there is no tendency for the leaves to behave differently relative to each other at different humidities.

There is obviously need for further investigation of the subject of water loss from the leaf. Here only the factors of time, humidity, and age of leaf have been considered, but such factors as temperature and moisture content of the leaf must also play a large part. The large increase in the field experiments of the department made during 1933 leaves little room, however, for such investigations under present conditions.

Manganese:—In conjunction with work in the agricultural chemist's department on soils containing abnormally large proportions of available manganese certain preliminary observations were made on tea seedlings.

A culture solution was made containing 0·50 grams ammonium chloride, 0·50 grams potassium nitrate, 0·25 grams magnesium sulphate, 0·25 grams potassium dihydrogen phosphate and a 0·25 grams calcium chloride and a trace of ferric chloride per litre.

Fig. II.

To one series 0·09 per cent. of manganese sulphate was added, the other series being maintained as a control. "Twinned" tea seedlings were used for the experiment, one "twin" of each pair being subjected to each treatment.

Within a week, leaf fall commenced on the plants over whose roots the solution containing manganese was circulated, the leaves first showing darkened areas and finally falling off. During the second week this continued, together with necrosis of the buds and young portion of the stem. (Figure II). At the beginning of the experiment the number of the leaves on the plants under the control and manganese treatments were forty-four and forty-eight, respectively. At the end of the experiment a fortnight later the numbers were twenty-six and three, respectively. The leaves lost from the control plants were old leaves and no sign of necrosis of the young leaves and stems occurred. At the termination of the experiment the plants were analysed in the Agricultural Department. The percentage of manganese in the oven-dry material was:—

		Control	Manganese.
Leaves	...	0·206	1·54
Stems	...	Trace	0·505
Roots	...	0·014	0·179

The results of a small pot-culture experiment which was performed in addition were complicated by the fact that a very large proportion of the added manganese sulphate was leached out during watering. The same tendency for there to be more manganese in the leaves than elsewhere was observed when the plants were analysed, while the amount of manganese in the experimental plants was again considerably more than in the controls.

Pruning Experiments:—Pruning experiments, involving as they do the collection and analysis of records over periods of from two to three years, cannot easily be divided into sections upon which progress reports can be made. Deductions made from the initial records may be entirely contradicted by later records. For example, cut across bushes yield more at the beginning of the cycle than clean pruned bushes but it would not therefore be justifiable to assume that this difference will remain throughout the cycle. It has therefore been decided to publish no full analysis of the records until the completion of the cycles at Galatura, Peradeniya, and St. Coombs. The collection of records from the pruning experiments still, however, occupies a large proportion of the energies of the department. The plan of the experiments has been fully described previously [3] and need not be further referred to here. Grateful acknowledgment is again due to the Director of Agriculture, Messrs. James Finlay & Co., Ltd., and the Amalgamated Tea Estates Co., Ltd., for the facilities provided at Peradeniya and Galatura respectively. Thanks are also due to the Superintendent of Galatura

for his willing co-operation in the carrying out of additional short term experiments upon the factors effecting recovery from pruning.

An account of certain investigations on dieback has already appeared [4]. The deduction was made that in the Low-country dieback after pruning can be substantially reduced by methods of pruning by which large numbers of leaves are left upon the bush during the recovery period. The best method for this purpose, of the three types of pruning tested, was a form of "rim lung" pruning in which six large branches were left upon the bush until ten days before tipping, when they were cut off to an outward eye.

This result indicated the need for further research to decide (a), Is the production of tipping shoots within the bush delayed by lung pruning ? (b), What is the best number of lungs to leave upon the bush ? (c), When should they be cut back and (d), Does dieback occur after the tipping stage is reached, and if so, does the type of pruning affect its amount ?

To determine these points an experiment involving the comparison of the following treatments was set out at Galatura, the pruning being done between the 11th and 23rd of May and tipping on the 4th August.

1. Clean Pruning.

2. (a). Three lungs left until 20th June ("Early").
   (b). Three lungs left until 20th July ("Late").

3. (a). Six lungs left until 20th June ("Early").
   (b). Six lungs left until 20th July ("Late").

The first collection of dieback took place on the 10th and 11th August, and the second on 31st October. The interval between pruning and the first collection of dieback was thus approximately equal to that between the first and second collection. If any extensive death of the lungs after pruning back occurred, it would therefore influence the values obtained in the second collection.

The number of lungs left provides a first approximation to the area of leaf surface remaining on the bush after pruning. A better estimate however can be made by means of leaf counts. The following results were obtained by this method.

Mean Number of Leaves per Bush.

Six Lungs		Three Lungs		Clean
"Early"	"Late"	"Early"	"Late"	
317	337	207	198	3

That the difference between the number of leaves on six lungs does not approximate to double that on three lungs is due to the fact that there

were not six equal sized branches suitably placed for lungs, it being necessary to use rather smaller branches to make up the number. This illustrates the danger of describing lung pruning merely by the number of lungs left. The leaf area is the important factor, and lung number is an inadequate guide to this.

Tipping took place on all treatments at the same time. The dry weight of material removed in tipping provides, therefore, a measure of the new growth produced under each treatment above the tipping level.

The dry weight of tippings in pounds per thousand bushes was :—

	Early	Late	Mean
Six Lungs	48·36	43·93	46·15
Three Lungs	32·90	38·40	35·65
Clean	—	—	21·91
Mean	40·63	41·17	—

The effect of lung pruning is very great, the weight of tipping material from the "six lung" pruned plots being over double of that from the "clean" pruned plots. Statistical analysis shows that the differences between the three treatments are all significant. The effect of early versus late removal of the lungs is not significant, indicating that on the whole no advantage is gained by leaving the lungs upon the bushes for the longer period. There is, however, a significant interaction between the number of lungs and the time of removal, most growth being obtained by early removal of the six lungs and by late removal of the three lungs.

These data effectively dispel the fear that the presence of lungs on the bush at low elevations in any way slows down the production of new shoots on the pruned portion of the bush. In fact the exact opposite occurs.

From the point of view of the production of new growth after pruning at low elevations in Ceylon, the following practical points emerge :

(a). Lung pruning is much preferable to clean pruning.

(b). The number of lungs is not an exact guide to their value—leaf area, to which a better approximation is given by leaf number, is the important factor.

(c). If about three-hundred leaves per bush are left, removal of the lungs can take place earlier than if only about two-hundred are left. The best periods in the present experiment were approximately one month and two months respectively.

Equally striking results on the reduction of the amount of dieback by lung pruning to those already reported [4] have been obtained during 1933. The number of pounds weight of dieback removed during the collections on August 10th and 11th, were per thousand bushes :—

	Early	Late	Mean
Six lungs	118·4	100·6	109·5
Three lungs	149·8	104·9	127·3
No lungs	—	—	236·9
Mean	134·1	102·7	—

The amount of dieback in the "lung pruned" plots is significantly less than that in the "clean pruned" plots, the difference between the six and three lung plots not being significant. The effect of time of removal is suggestive, but not significant, while there is also no significant interaction between time of lung removal, and lung number.

The results of the second collection of dieback on 31st October, indicated that dieback occurred after tipping as well as before. The amounts found were :—

	Early	Late	Mean
Six lungs	47·5	51·3	49·4
Three lungs	48·0	38·8	43·4
No lungs	—	—	50·5
Mean	47·8	45·1	—

Pruning treatment and time of lung removal had no effect on the amount of post-tipping dieback.

The close parallelism between the effect of pruning treatment on the dieback of frame branches after pruning and on the number of deaths after pruning leaves little doubt that both owe their origin to the same cause, *i.e.* a deficiency of carbohydrate reserves at the time of pruning.

The number of deaths per thousand were :

	August 10th & 11th	October 31st	Total
Six lungs	5·0	2·5	7·5
Three lungs	7·5	1·9	9·4
No lungs	48·1	8·1	56·2

On both occasions the difference between the number of deaths in the six lung and three lung plots is not significant, but both the lung treatments result in significantly fewer deaths than when no lungs are left.

A character common to all the dieback experiments which have been performed by the Institute is the large error associated with the experiments, indicating the action of uncontrolled factors. It has been demonstrated that it is possible to reduce the amount of dieback occurring in clean pruned fields by forty-five per cent. and the number of deaths by eighty-seven per cent. by the substitution of lung pruning for clean pruning. It now remains to determine whether it is possible to reduce still further the amount of dieback and the number of deaths after pruning. The most promising line to this end is to identify the "uncontrolled factors" mentioned above, and for this purpose laboratory investigations are being carried out on roots and branches obtained from the experimental plots. They have not, however, progressed sufficiently far as yet to justify discussion.

It is still the case that the majority of Low-country tea is pruned in such a way that far too few leaves remain upon the bush during the recovery period. This is perhaps due to lack of appreciation of the seriousness of the dieback question. The results of the experiment previously reported [4] showed that, even if the damage to the frame and the considerable loss of crop resulting from dieback were ignored, the capital value of the bushes saved amounted *alone* to Rs. 59·00 per acre. On a similar basis the results of the present experiment show a saving of Rs. 74/- per acre by leaving six lungs per bush at pruning time and Rs. 70/- per acre by leaving three.

But this only represents one side of the question. The yield records show a considerable increase in crop to result from lung pruning as compared to clean pruning. This effect on the growth of the bush is also reflected in the general appearance of the bushes and in their size. The measurements of the average diameter of the frames of rim lung pruned and clean pruned bushes just after pruning, previously reported, showed that the mean diameter of the former is distinctly greater than that of the latter. Measurements made fifteen months after pruning at Galatura showed that the mean diameter of the plucking surfaces of the clean pruned bushes was 32·29 inches, while that of the rim lung pruned bushes was 41·24 inches—an increase of 27·7 per cent. This difference may be ascribed to the effect of the method of pruning on the diameter of the pruned frame, the better recovery and, especially, the reduced amount of dieback. It may be noted in passing that the figures for the diameter of the plucking surface in lung pruned and clean pruned plots provide an answer to the fear that is sometimes expressed that the lung branches will die back after being pruned. If this had occurred to a considerable extent, the lungs being outside branches, it is very unlikely that such a large difference in the diameter of the plucking tables would be observable. In addition to this we have

the evidence already given that there is no extra post-tipping dieback in the lung-pruned plots, and the field observation that no apparent tendency exists for the lungs to die back to a greater extent than other branches.

Jepson [5] states that "As regards the mode of entry into living plants it can be stated with certainty that, in the case of *C.* (*Calotermes*) *dilatatus*, entrance to bushes and seed-bearers . . . . . is gained by the winged forms of the colonising flights only through dead 'snags' and wounds. The point of entry into tea bushes and seed-bearers by *Calotermes militaris* is not yet known. It will probably be found to be effected in a similar manner to that of *C. dilatatus* . . . ." In addition, it is by now well-known that dead snags are very frequently the point of attack of fungal wood rotting organisms. All these facts combine to render the elimination of dieback a problem of major importance and one to which too great attention cannot be given by those responsible for the working of estates. In this connection the moral may be drawn that "economy" obtained by clean pruning instead of lung pruning may well prove the original cause of considerable losses subsequently.

The Institute has in the past advised resting before pruning at low elevations as a measure of precaution against dieback. It appears that this treatment may not be uniformly efficacious under different climatic conditions. Work at Tocklai [6] has led to the conclusion that both in plucked bushes and in seed-bearers (which may be regarded as equivalent to rested bushes) rapid growth is accompanied by a diminution of starch reserves. Resting the bushes during "rush" months is therefore unlikely to be of material use, but resting during the periods of lower yield is still advisable in cases when lung pruning cannot be carried out.

The field on which the 1933 dieback experiment was carried out was rested for five months—January to May. During this period a "rush" of growth occurred. It will be noted that the amount of dieback on the clean pruned plots is as large as that reported for the 1932 experiment [4]. If resting had been done during a period of slow growth and followed by pruning before the quick growth of April and May, it is probable that dieback would have been reduced.

Collar pruning provides an example of a case in which pre-pruning resting is of great importance in the Low-country owing to the fact that it is impossible to leave lungs upon the bush.

It is desirable therefore to rest the bushes to be collar pruned during the low-yielding period of the year and to prune just before the rush period. In a district having dry weather during January, February and March for example, it would be advisable to collar prune towards the end of March. By so doing, the bush is prevented from using up its accumulated reserves in producing leaves and shoots after the onset of the rains in April.

Certain data providing additional information on this relation between pre-pruning growth and dieback have been obtained. Thirty bushes were pruned at the end of April 1932, and their individual yields recorded until the end of the year. On the 5th of January, 1933, they were again pruned and the weight of dieback per bush found on 3rd April, 1933. No correlation was found to exist between the individual yield during the previous year and the amount of dieback per bush after the second pruning. In other words, there was no tendency for high-yielding bushes to give more or less dieback than low-yielding bushes. A significant positive correlation was, however, found between the yield of the bushes during the four last pluckings and dieback after pruning. This indicates that those bushes which yielded heavily during the month previous to pruning were more liable to dieback than those which had yielded less in that period. This data, as well as the conclusions already mentioned, (6), suggest that fields liable to dieback should not be pruned during, or immediately after, rush periods.

A further point in connection with dieback has arisen this year. It appeared from the results of the 1932 experiment (4) that cutting across three inches above the previous clean prune level resulted in a considerable amount of dieback, although significantly less than occurred in clean pruned plots cut at the same height. Cutting across is usually regarded as a "light" form of pruning, but it appears that "light" pruning is *no* protection against the incidence of dieback unless the method results in a large number of leaves being left on the bush during the recovery period. As an example, the case of a field may be cited that was very lightly pruned (half-an-inch above the previous tipping level) in the cycle following on a clean pruning. The field as a whole did not have many low leafy branches, with the result that comparatively few leaves were left on the bush. A collection of dieback at three different points in the field gave a mean weight of four-hundred pounds per thousand bushes, or say, twelve-hundred pounds per acre. Comparison with the experimental figures already given shows that more dieback may occur after "Travancore" pruning than after clean pruning. In fact, these figures are the highest yet recorded for dieback.

Where successive "Travancore" prunings are practised the danger of dieback is not likely to be nearly as great on the subsequent occasions as on the first occasion, as more leaves will be present below the pruning level. Where, either in the first or in subsequent "Travancore" prunings, too few leaves are left upon the bush, the method should be modified in such a way as to correct the fault. This will involve slight increases in pruning costs, but the advantages resulting will compensate for the extra cost many times over.

THE EFFECT OF PLANTING METHOD ON THE SUBSEQUENT GROWTH OF THE PLANT.

The results obtained in 1932 on this subject have been discussed [7] but may be summarised here. The three treatments examined were:

(a). Seedlings planted after all leaves and green stems had been removed, the roots being left untouched.

(b). Seedlings treated as in (a) but with lateral roots trimmed off, leaving only the taproot.

(c). Seedlings planted after main stem was cut back to six inches above the collar, the roots being left untouched, but with the lateral roots trimmed off.

Detailed measurements were made in April 1933, twenty-one months after planting, on the bushes in the plots planted according to methods (a), (b) and (c) in order to determine whether these three methods of planting affected the subsequent growth of the bushes. It was found that height of the bushes in the treatment (a) was not significantly greater than that of the bushes in (b), (Table III). The plants subjected to treatment (c) were distinctly shorter than those in the (a) and (b) plots. This is to be partly attributed to the fact that new growth in this treatment is restricted to a length of six inches of stem above the soil level, whereas in the other two treatments new shoots were produced much higher up.

TABLE III.

GROWTH MEASUREMENTS.

	Treatment	(a)	(b)	(c)	Significant difference
(1)	Mean height of plants before pruning	89·1 cm.	85·5 cm.	54·0 cm.	7·1 cm.
(2	Mean weight of prunings per plant	0·51 lb.	0·46 lb.	0·17 lb.	0·09 lb
(3)	Mean weight of leaves per plant	0·22 lb.	0·20 lb.	0·08 lb.	0·04 lb
(4)	Mean diameter of stem at ground level	1·47 cm.	1·44 cm.	1·13 cm.	0·18 cm.

At the end of April, the plants in treatment (a) were centred at three inches above the ground level, those in treatment (b) at four inches, while those in treatment (c) were pruned back to two inches above the level of the stumping cut. The fresh weight of prunings showed that more was removed from the (a) and (b) plants than from the (c) plants (Table III). This was to be expected, owing to the absence in the (c) plot prunings of the large portions of central stem present in the prunings from the other

two series. A measure of the new growth produced since transplanting is to be found in the fresh weight of leaves on the prunings. Since no leaves were left on any of these plants when transplanted, all the leaves found must be associated with new stem growth. The results showed that the (a) and (b) plants did not differ significantly in this respect, but that both had more leaves than the (c) plants, (Table III). The difference is far too large to be attributed to the difference in pruning levels.

The thickness of the central stem at ground level showed similar differences, the bushes in (a) and (b) plots having significantly thicker stems than those in the (c) plots (Table III). In general, therefore, the plants from which only the leaves and green wood were removed before planting made more growth than did the plants which were cut back to six inches above the collar.

YOUNG TEA PRUNING EXPERIMENT.

The area used for the experiment on methods of planting was converted this year to provide data on the different methods of pruning young tea. For this purpose, four methods were selected arbitrarily and two experiments commenced.

The Schedule for Treatment is :—

Treatment	A	B	C
1933 April.	Cut 2 in. above stump level. Small side branches to be left.	Centre 3 in. leaving lungs or side branches.	Centre 4 in.
October.	—	Cut back gourmandisers & lungs.	—
1934 April.	Cut 2 in. above last prune. Side branches to be left.	Cut back gourmandisers.	Prune 10 in. Tip 6 in. above & bring into plucking.
October.	—	Cut across @ 15 in.	—
1935 April.	Cut across at 20 in. from ground level and take into plucking.	—	—

Treatment	A	B	C
October.	—	Prune at 12 in. tip at 4 in. and take into light plucking	
1936 April.	—	—	Travancore prune.
October.	Prune 3 in. above 1934 prune. Take into plucking.	—	—
1937 April.	—	—	—
October.		Travancore prune.	Travancore prune.
1938	—	—	—
1939 April.	Rim lung prune 18 in.	Rim lung prune 18 in.	Rim lung prune 18 in.

Records of the various operations and growth records will be kept, to enable a comparison of the treatments.

The second experiment involves the comparison of "thumb nail" pruning of young tea with that of "B" above.

RESTRICTION EXPERIMENT.

The introduction of restriction brought certain problems to the fore that had not previously been of immediate importance. Two additional major field experiments were therefore undertaken to enable their elucidation. The two problems attacked were, (a) the effect of variations in the length of the plucking round, and (b) the effect of resting after pruning. The full value of the experiments could not be obtained by field observations alone and arrangements were therefore made to manufacture the experimental leaf to enable observations on the made tea to be made.

(a). The effect of variations in the length of the plucking round.

The experiment consists of twelve randomised blocks of two plots each. One plot of each pair is plucked every seven days and the other every fourteen days, care being taken to ensure that the standard of fineness of plucking is as far as possible the same for both treatments. It may be mentioned that fine plucking is being performed, but that the average size of the fortnightly flush is larger than that of the weekly flush, owing to the leaves having developed during the extra week.

Results are available over a period of sixteen weeks, and indicate that crop is reduced considerably by the longer plucking round.

(b). The effect of resting tea after pruning.

An experiment has been commenced, but results are not yet available, of the effects of:

(a). Tipping and plucking at the normal time.

(b). Resting untipped for three months after (a) has been tipped.

(c). Resting untipped for six months after (a) has been tipped. The rested plots will be cut across at the level reached by the plucking surfaces of the plots which have not been rested.

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F. R. TUBBS,

Plant Physiologist

REPORT OF THE AGRICULTURAL CHEMIST, 1933.

Staff:—In consequence of the resignation of the Biochemist, the Agricultural Chemist has been in acting charge of the Biochemical Department for the nine months commencing April 1st., 1933.

Advisory:—In the Agricultural Department 195 letters were received and 187 despatched. The necessity for economy in estate works has not lessened the enquiries relating to manurial and cultivation treatment; in fact the proportion devoted to these subjects has increased. Although in some quarters there has been a tendency to discount the value of research and advisory work on the purely cultural side because the results of such work are not immediately visible and times are hard, the enquiries received show that this view is by no means general. At no time during the six years that the department has been in existence has more interest of a fundamental nature been shown in manurial practice than at present. There is, however, much further scope for educational and advisory activities for it is still a very prevalent idea that to state the total quantity of manure applied per acre, without respect to its composition, is a sufficient indication of manurial practice. The advice given by the Institute is based on the study of the fundamental principles of soil technology, and on the accumulating results of the Institute's field experiments; and if the recommendations are to be supported by trustworthy data an increase in our activities on these lines rather than a decrease will become inevitable.

In the Biochemical Department 382 letters were received and 348 despatched. The largest percentage of inquiries devoted to one subject was concerned with firing. This aspect will be dealt with more fully later.

AGRICULTURAL DIVISION.

In view of the supervision of the Biochemical Division during the greater part of the year, no new activities in the agricultural chemical laboratories were started during the year. Laboratory work in connection with immediate advisory enquiries continues to occupy a fair proportion of time as do also analyses in connection with the normal conduct of field experimental work.

Publications:—

Soil Erosion:—Imperial Bureau of Soil Science, 1933, Technical Communication No. 28.

This paper reviews the most important work throughout the world up to and including 1932. It is primarily intended for technical officers, but in a shortened and less technical form is appearing serially in *The Tea Quarterly*.

The Manuring of Tea:—Empire Journal of Experimental Agriculture, 1933, Volume 1, 297.

A critical review of the history and present practice of tea manuring illustrated by experimental results from India, Java and Ceylon.

On the Validity of Fisher's Z test when applied to an actual example of non-normal data:—(With F. Yates). Journal of Agricultural Science, 1933, Volume 23, 6.

This is a purely technical paper dealing with statistical method. It removes an element of doubt as to the suitability of these methods for the interpretation of field experiments.

The Occurrence of Manganese in Soil:—Manganese in estimable quantities is of very common occurrence in tropical soils and to some extent makes its way into the growing plant. It apparently belongs to that group of elements which are necessary in small quantities, though the manner in which they function is not satisfactorily elucidated. It is suggested by Bertrand (Russell, Soil Conditions) that manganese is needed for the activation of peroxides in plants, and in this connection Shaw (U.P.A.S.I., Annual Report 1931-32) points out that this theory is suggestive in the case of tea, where an oxidising enzymic action is known to play a large part in the preparation of tea from the leaf of the plant.

The beneficial effect of manganese is however severely restricted to small quantities, and if the optimum quantity is exceeded toxic effects on roots and leaves appear. The range of usefulness and toxicity has become of interest, because several cases have come to our notice where tea in an unhealthy condition, or suffering from delayed development, has coincided with a higher manganese content of the soil than on adjoining good tea without any other traceable abnormality.

In two cases the increase in manganese content of the soil has been followed up by an examination of the leaf samples which as shown in the analyses carried out for the Physiological Department (q.v.) appears to absorb the element in higher concentrations than the other parts of the plant.

Percentage Manganese.

	Soil		Flush		Old Leaf	
	Good	Bad	Good	Bad	Good	Bad
Estate A.	0·017	0·031	0·033	0·041	0·048	0·053
Estate B.	0·032	0·114	0·048	0·033	0·103	1·211

The results are not conclusive one way or the other probably because age of leaf and position in the bush are bound to affect the manganese concentration, and designations such as flush and old leaf are not distinctive

enough to affect a high enough degree of comparability. Moreover, there is the anomaly that frequently arises in comparative soil work, that a state of soil which on one estate appears in conjunction with poor tea is no worse than a similar state of soil bearing good tea elsewhere. A constant lookout is being kept for further examples, as it is only by casting the net as wide as possible that sufficient data for the study of this problem can be collected.

Green Manures:—Experiments on the establishment and treatment of bush green manures and cover crops have been continued in the past year. The main results have been to confirm the choice of species which are daily becoming more commonly used. Such are:

Tephrosia vogelii.
Tephrosia candida.
Crotalaria anagyroides.
Crotalaria usaramoensis.

Two promising species which are not so wide-spread are:

Cassia Leschenaultiana.
Indigofera arrecta.

The former spreads quickly, seeds freely, and can very rapidly be multiplied. It seems especially suitable for contour planting or edging of drains.

Other species showed less hardiness but are worth watching; these include:

Clitoria cajanifolia,
Cassia devaricata,
Desmodium gyrans,
Desmodium gyroides, } Low cover.
Centrosema plumieri.

Definite failures that would not stand the climate were:

Cassia tora,
Crotalaria juncea,
Tephrosia noctiflora.

Crotalaria semperflorens is very liable to attack by caterpillars of the Argina genus which will sometimes strip it of leaves completely, and moreover it will not stand lopping except in a very young condition.

Of species that provide tree shade the most promising were:

Cassia levigata,
Calpurnea aurea,
Hakea saligna.

Calpurnea aurea, a South American species, has been successfully used in the Kenya highlands and has the reputation of being resistant to drought conditions. Hakea is non-leguminous and is being cultivated in South India as windbelt material to supplement Grevillea.

Whilst it cannot be said that the search for a suitable ground cover has reached success, the trials of the last few years have clarified the position. *Indigofera endecaphylla* remains the chief standby because it creeps, and whilst it will climb it does not twine nor take hold with tendrils. Its main disadvantage in our opinion is not its control above ground, but its control below the surface. It produces a very vigorous tap root, exploits the same soil layer as tea itself, and renders cultivation more difficult and costly. Two shallow rooting species devoid of these disadvantages have been tried, *Parochetus communis* (as mentioned in the previous report) and *Smithia blanda*, another indigenous species. The limitation of both these are now becoming visible; they die away in the dry weather and behave as annuals, having to re-establish themselves from their own seeds which are quite prolifically produced. Their main disadvantage is that their re-establishment by this method is a slow process, and the ground remains bare during the period of intermonsoon thunder showers which are such an important factor in causing soil erosion. At the moment then we are forced to choose between a deep rooting species and a shallow rooting species, both with attendant, but different disadvantages.

As an attempt to bridge this gulf a start has been made with *Trifolium subterraneum*, the subterranean clover used largely in the drier zones of Australia. The root system of this is moderate and there should be no difficulty in drought resistance. It has survived a severe South-West Monsoon. At present it does not take kindly to transplantation and seems to require establishment by broadcasting the seed.

MANURIAL EXPERIMENTS, ST. COOMBS.

The experiment on incremental doses of nitrogen and potash completed its first pruning cycle in November. The consideration of the whole period as a unit is reserved for report later. Following the custom of previous years, the results for the year's working are given here.

The accuracy of the experiment remains high, though not so high as previously; this is only to be expected after three years in which the individuality of bushes though controlled, has had time to make itself felt cumulatively. The yields for the 3rd year are shown in Table I.

TABLE I

Yields and Errors from Potash and Nitrogen Experiment (3rd Year).

	Nitrogen.			Potash			Blood meal	Sulphate of ammonia	Cyana-amide.
	No N	20 lb. p.a.	40 lb. p.a.	No K	20 lb. p.a.	40 lb. p.a,			
Yield p.a. lb.	582	672	742	672	653	670	701	732	688
Significant dif.		48·4			48·4			59·3	
Yield % of mean.	87·5	101·0	111·5	101·1	98·2	100·7	99·2	103·5	97·3
Significant dif. %		7·3			7·3			8·9	

In general effect these results follow the previous year's: nitrogen has shown response whilst potash has not. There is no distinction between the types of nitrogen used. With regard to the figures for the increments of nitrogen the net gain due to the application of 40 lb. per acre was 160 lb. dry weight which is a good estimate of made tea. This gain is the increase in crop in comparison with tea that has remained unmanured for three years. Since the figures quoted above are averages of all the plots receiving nitrogen, and since there is an equivalence between the yields from the different kinds of nitrogen, they show that it is possible to use inorganic nitrogen without causing the excessive growth of flush that leads to deteriorated quality. This is further brought out by the actual yield curves (which are too extensive for publication here) which show that the distribution of yield throughout the year is exactly similar for sulphate of ammonia, cyanamide and blood meal. In a word, there is as yet no sign of a cumulative disadvantage due to the employment of inorganic nitrogen.

Of further interest are the gains due to nitrogen at the two levels. The percentage yield shown for 20 lb. of nitrogen is 101. The fact that this lies so close to the mean for the three levels, i.e., 100, shows that the efficiency of nitrogen in producing crop is very nearly the same whether the lower or the higher quantity is used. The economic return for the first dose is 90 lb. and for the extra dose 70 lb., the difference of 20 lb. being well below the significant difference.

The value of the return for manuring is seldom in dispute but an approximate figure may be here quoted. Using the St. Coombs figures for cost of production and profit, the use of a mixture of composition Nitrogen 40 lb., Phosphoric acid 30 lb. and Potash 20 lb. has produced an extra crop with an average profit per acre of Rs. 50/. If we put against this the cost of manuring, including application, which amounts to Rs. 20/-,

there remains a balance of Rs. 30/- per acre. Actually this is an understatement of the profit, because the St. Coombs cost of production figure included manuring. To have deducted the manurial costs from this would have over corrected the figure since the gross yield would have had to be corrected by reduction. As the figure stands it gives a conservative estimate of the value of manuring.

Passara Sub-Station:—Towards the end of the year the Passara Sub-Station was made available for agricultural work in addition to the control of Nettle Grub. Of the two manurial experiments projected, one has already been laid down.

This experiment asks three questions.

(1) What is the effect of inorganic manuring in comparison with organic? In this experiment the scope of the inquiry is not restricted to nitrogen only but includes inorganic and organic phosphoric acid also. The following sources are used:

	Organic.	Inorganic.
Nitrogen	Sterilized animal meal Blood meal.	Sulphate of ammonia
Phosphoric acid.	Sterilized animal meal Bone meal.	Superphosphate.

(2) What is the value of an enhanced phosphatic dressing in the pruning mixture? The two levels compared are 30 and 60 pounds phosphoric acid per acre.

(3) The effect of applying the 'pruning mixture' at three alternative times, viz. 2 months before pruning, at pruning time, and 2 months after pruning.

As in past designs of field experiments, each plot contributes to the answering of each question; so that there are 18 comparisons relevant to questions 1 and 2 and 12 to question 3 in the whole experiment of 36 plots.

A new departure in technique will be made in this experiment. Instead of each plucking being weighed and recorded, only every third will be so treated. This decision will enable more experiments to be done with the same personnel, and in support of the method detailed investigations have been made on data previously accumulated to show that the method involves no material loss in information or accuracy.

FACTORY AND MANUFACTURE.

Firing and moisture Content of Teas:—For the purpose of advisory enquiries 1819 samples of tea, fully fired or in the process of firing, were examined for moisture content. The results of these tests show that at the present time there is less standardisation in the firing process than one would

like to see. Apart from the immediate interest to the senders, the results have enabled us to locate a number of errors and difficulties in the drying process.

Teas continue to reach us with moisture contents as high as 9 per cent. Such samples probably indicate a combination of faulty drying in the first place and absorption of moisture during the accumulation of a break. These faults are not so easily amended by final firing as is sometimes imagined. The hygroscopic nature of tea is such that final firing at low temperatures with rapid discharge may frequently hardly affect the moisture content of the tea.

Teas carrying an excessive amount of moisture are gravely prejudiced in keeping quality. It is not possible to say whether all teas of high moisture content 'fade out' in transit, for the simple reasons that we have no exhaustive data of moisture contents of such teas with the corresponding Colombo and London reports, but in the increasing number of cases where such data has been made available, the fading out has invariably been associated with high moisture content. Moveover in tracing the subsequent history of teas from these sources, a regulation of moisture content has been followed by the disappearance of the complaint. For similar reasons it cannot be claimed that no other factors are ever involved. This phenomenon received some ventilation in the local press at the end of the year when immaturity of leaf was claimed as the cause. This hypothesis (for it cannot rank higher) has the disadvantage that, in the absence of any evidence to support it, it merely seeks to explain an occurrence about which little is known, by another consideration about which equally little is known.

The facts so far in our possession indicates that the moisture content of tea is an important factor in its keeping quality, and that it is dangerous to neglect this aspect. The routine determination of moisture contents would enable a valuable indirect check to be kept upon the adequacy of the preceding processes, and now that a simple and inexpensive apparatus is obtainable for this purpose, it is not too much to hope that increasing use will be made of it. Samples tested in these laboratories, whilst of definite help to estates, are less valuable than those done on the spot, because by the time a report is submitted the chance of rectification (if needed) has been missed.

As an example of how moisture determinations act as a check on manufacture generally, we may cite a test of dryer performance carried out on these lines. A five-tray dryer had been fed with third dhool at the

rate of 18 pounds per tray, giving a not too satisfactory moisture curve for successive trays viewed in the light of the recommendations of Bulletin No. 9. A reduction of load to 13 pounds overcorrected the fault, so in a third trial 15 pounds per tray was fed. The results revealed that drying was more faulty than the original test with 18 pounds, and the fault was in the same direction—failure to effect efficient evaporation on the early trays.

The data are tabulated in Table II.

TABLE II.

Moisture Evaporation in Dryer.

Tray.	% Moisture	Weight of dhool in lb.	lb. of water to evaporate		Dry matter lb.
		Load 18 lb. per tray.			
As fed.	52·4	18	9·45		8·55
1	51·0	17·4	8·88	2·45	
2	45·1	15·6	7·00		
3	36·8	13·5	4·95		
4	12·0	9·7	1·15	6·49	
5	5·7	9·1	·51		
		Load 15 lb. per tray.			
As fed	59·2	15	8·93		6·07
1	56·3	13·9	7·80	1·40	
2	55·5	13·6	7·53		
3	48·0	11·7	5·58		
4	14·6	7·1	1·03	7·05	
5	7·4	6·6	·48		
		Load 13 lb. per tray.			
As fed.	50·2	13·0	6·52		6·48
1	29·2	9·2	2·67	5·66	
2	11·6	7·3	·86		
3	8·3	7·1	·59		
4	4·5	6·8	·31	·60	
5	3·8	6·7	·26		

The initial moisture content allows of the calculation of a dry matter figure in pounds which is constant for each tray. For any given moisture content, the water to be evaporated can be derived from the formula

$$\text{water} = \frac{\text{Dry matter} \times \text{Moisture content}}{100 - \text{Moisture content.}}$$

The dhool weight follows from the combination of dry matter and water to be evaporated.

On studying these results the indications gained from crude moisture contents are further confirmed and elucidated. The 18 and 15 lb. loads have had little evaporation on the first two trays; the 13 lb. load has had the bulk of the work done on it on the first two trays. Although, in comparing the 15 lb. with the 18 lb. example, a reduction in load of some 16·7 per cent. has been made, the corresponding reduction in water to be evaporated was only 5·5 per cent.

The difference in wither furnishes the key to the problem, and until wither standardisation is more advanced, examples such as this must frequently occur, and with a standard setting of the dryer, disappointing results will continue to be obtained.

Tests of machinery performance:—Any comparison between teas manufactured so as to compare some conscious variation in treatment assumes that all other factors are kept as constant as possible. To this end the manufacture of teas from experimental plots has been carried on with small scale machinery which allowed of simultaneous manufacture on similar machines. During the past few months special attention has been paid to the performance of these machines and a close check taken on their deviations from strict comparability. The outcome of this work has had wider implications than those originally contemplated and is in course of extension to the normal factory plant.

Roll-breaking:—The criterion originally selected by which to compare the efficiency of rollers was dhool out-turn, so that inevitably the first point to be considered was roll-breaking. As a result, direct evidence of the importance of the method of feeding was obtained.

Table III gives the dhools produced in half ounces from a series of similar 14 lb. samples by two coolies A and B. On ten out of thirteen occasions on the same roll-breaker B produced more dhool than A. The average difference between the two was just over 18 ounces and the significant difference required is 14·5 That is the odds are greater than 100 to 1 that if a difference of more than 14·5 ounces of dhool exists between the two, that difference is due to the cooly and not to chance causes.

TABLE III.

Differences between two operators feeding leaf to the same roll-breaker.

A.	B.	B-A	
235	230	− 5	Standard error.
214	240	+ 26	
219	243	+ 24	4·75
216	238	+ 22	
194	228	+ 34	Significant difference.
219	200	− 19	
188	202	+ 14	14·5
274	294	+ 20	
278	308	+ 30	
284	279	− 5	
237	268	+ 31	
258	285	+ 27	
249	285	+ 36	
Mean		+ 18·08	

The reason for this discrepancy was found to be the way in which the two coolies fed the rolled leaf, there being no feeding mechanism on these roll-breakers. A simple type of distributor was fixed and the same coolies made to operate the machine. On this occasion the results showed that satisfactory standardisation had been attained and that B no longer on the average turned out more dhool than A.

TABLE IV.

Differences between two operators feeding leaf to the same roll-breaker.

(With automatic Distributor.)

A.	B.	B-A
141	157	+ 16
169	161	− 8
132	136	+ 4
146	138	− 8
119	118	− 1
112	120	+ 8
90	87	− 3
95	87	− 8
Mean		0

Even when precautions of the above nature are taken to ensure even dhools, there still remains an unavoidable variation in quantities of dhool turned out on any one occasion from equal quantities of exactly similar leaf, and it is of some importance to assess how great this variability is. This has been done under three sets of conditions:

(a) without feed on oscillating roll-breaker.

(b) with feed on oscillating roll-breaker.

(c) without feed on a rotating roll-breaker.

The percentage error involved in the three cases is (a) 8·9 per cent. (b) 6·7 per cent. (c) 5·1 per cent. As far as results go, the rotating pattern appears to give the most consistent out-turn. The nature of the process will probably preclude any reduction of error beyond these figures.

Rolling:—The next step in machinery standardisation was to examine rolling pressure. Several simple pieces of apparatus are on the market for measuring pressure by means of spring contraction. Some of these are calibrated in pounds; other do no more than measure the contraction in inches and half inches. Using a more delicate adaptation of this principle the four experimental rollers have been calibrated in pounds and are found to agree closely, equal compression giving within narrow limits equal pressure.

The relationship between compression and pressure is linear, that is, an increment of contraction from 0 to 1 inch in the spring will give the same increment of pressure as an increment of contraction from 1 to 2 inches. As this measure of pressure is in frequent use with commercial rollers, it may be pointed out that by increasing spring contraction from one inch to two the pressure applied is not doubled. This is because the weight of the cap has to be considered and this is the same whatever contraction is used. This may be made clear by giving data determined on a Jackson's Rapid Roller 36 in. diameter. Pressure values may be obtained for any contraction either by reference to the appropriate graph constructed experimentally, or from the mathematical equation which defines that graph in general terms. The latter was found to be

$$\text{Pressure in lb.} = 330 + 12{\cdot}83 \times \text{gauge reading in mm.}$$

At 10 mm. gauge $P = 458{\cdot}3$ lb.

At 20 ,, ,, $P = 586{\cdot}6$ lb.

At 25 ,, ,, $P = 650$ lb.

Approximately then 1 inch spring contraction on this roller gives 650 lb. pressure. In terms of pressure per square inch the corresponding readings are:

1 inch = ·64 lb. per sq. inch.

1½ inch = ·80 ,, ,, ,, ,,

2 inch = ·96 ,, ,, ,, ,,

Hard rolling does not appear to give the pressure which, without consideration of the question, one might have expected.

During the process of rolling under pressure the pressure is by no means constant. As the leaf becomes compacted pressure falls and is restored from time to time by turning the pressure wheel. In order to determine how variable the process is, a number of records on the Jackson's Rapid Roller have been kept. It was desirable that the record should be as continuous as possible and in default of special apparatus recourse was had to a Cassey-Armitage gauge which was modified in an important particular. As ordinarily used this gauge is worked off the cap and records the position of the cap. The fact of pressure being applied is inferred from the position of the trace on the revolving drum and from the serrated nature of the trace. In the case under consideration the stylus was attached not to the cap but to the flange of the spring spindle, so that the movement of the recording stylus actually measured spring compression. Figure I gives a reproduction of an actual trace made for a second roll with alternate periods without and with pressure.

This kind of trace clearly shows two things, (a) that pressure fluctuates widely over short time intervals according as the resistant forces of leaf and battens come into play and (b) that quite appreciable drops in pressure occur when readjustments of the pressure wheel are not made very frequently. The continous line superimposed on the oscillating pencil trace gives the approximate mean pressure at successive momentary time intervals.

It is at once evident that any exact study of the effect of different schemes of rolling will have to take into account the practical variation that these data show to occur normally. Whilst it is possible that these variations may turn out to be of minor importance, it must be conceded that in order to satisfy ourselves that such is actually the case, we must realise that they exist and have some method of measuring them.

Work done in Rolling:—The idea of pressure in rolling and its desirability or otherwise occupies a dominating position in the ordinary practical conception of the process, but it must not be allowed to overshadow other important factors. Rolling pressures have been demonstrated as being moderate in degree, and this very fact tends to emphasize the desirability of exploring the intensity of the effect produced by the other prime factor in the process, the movement of the leaf.

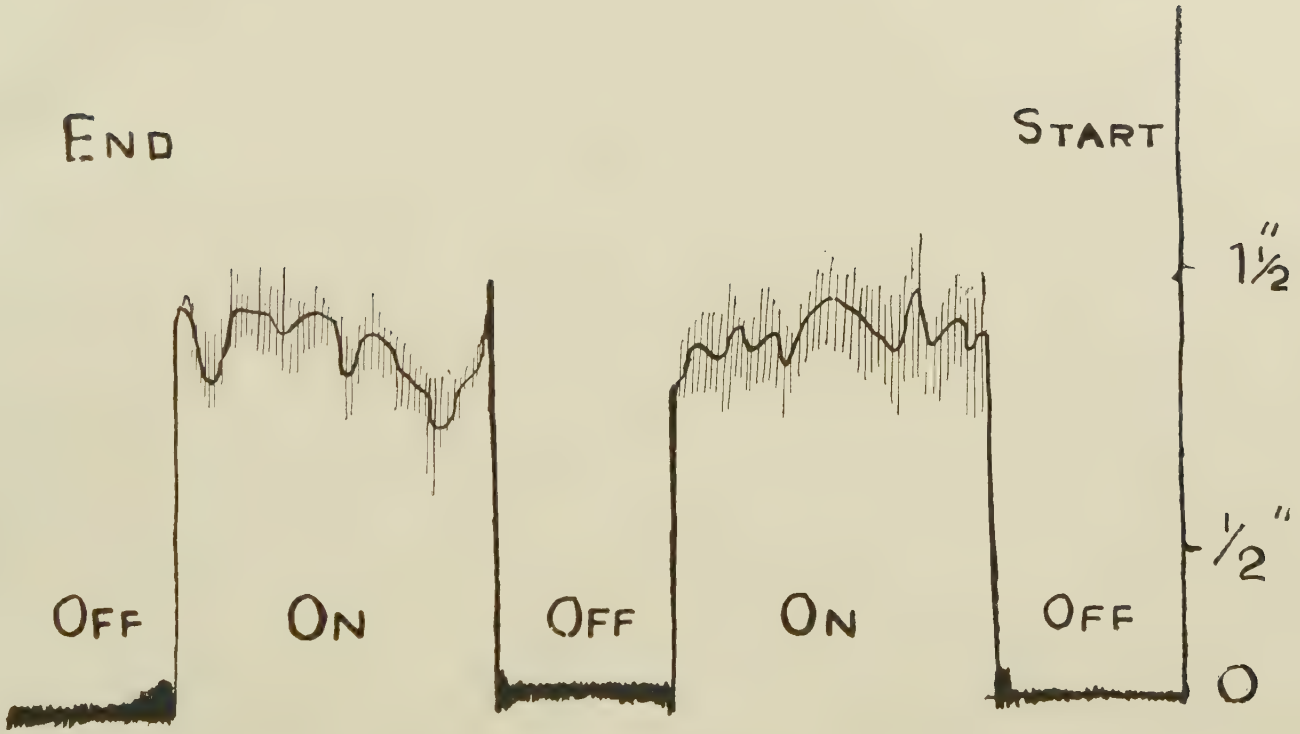

Fig. I.

PRESSURE TRACE FOR JACKSON'S RAPID ROLLER.

The measurement of effective motion of the leaf mass is not directly possible. It can be shown theoretically that ideally every particle of leaf at the table surface should describe a circle, the radius of which is the sum of the throw of the two cranks in a double action roller, or the single throw in a single action machine; and that this path is independent of the position of the particle with respect to the sides of the box. In actual practice this ideal motion which could be calculated from roller dimensions and roller speeds is not adhered to, because of friction on the table surface, interference of battens, variable shearing effect as between moving box and moving table and so on. Indeed one can continue to enumerate considerations which make such a theoretical figure valueless. The leaf in a box has an appreciable thickness and only reaches the table more or less infrequently. The fact is that both pressure and motion considered separately are highly artificial standards by which to measure roller performance. What really matters is not the total motion but that component which is made under pressure; not total pressure so much as that component which acts in the direction of the variable motion.

This standpoint, whilst it appears at first sight to place one in a dilemma, actually throws one back on to the sound mechanical principle that the most rational approach to rolling is in terms of 'work done', the product of these components of pressure and motion which are coincident. The more the question is examined the more obvious it becomes that roller performance is a question of power. It may be that increase of power may be most conveniently and profitably made by pressure adjustments, but the fundamental unit for consideration is *work* in the mechanical sense.

An attempt has been made to develop this conception in practical terms and interesting results have been obtained. The problem of how to measure work done was solved by having recourse to rollers operating on a direct drive from an electric motor. Direct drive eliminates power wastage through belt slip, and electric traction provides a ready means of measuring power consumption. Through the kindness of Mr. J. A. Cochrane, Chief Engineer to the Anglo-Dutch Plantations of Java Ltd., who specially assembled the necessary equipment for a trial, a specimen series of data was obtained. We are indebted to him and to the Directors of the company for permission to comment on the results obtained.

Over a series of four rolls the power consumption was measured by a watt meter, the indicator of which carried a pen producing a continuous trace on a chart fitted to a revolving drum after the manner of a barograph. Figure 2 is a facsimile of the chart which shows a complete record of the rolling operation. The procedure followed is different from that prevalent in Ceylon. Rolling is very light according to our notions, and no release of pressure is made throughout the period of a single roll. Despite

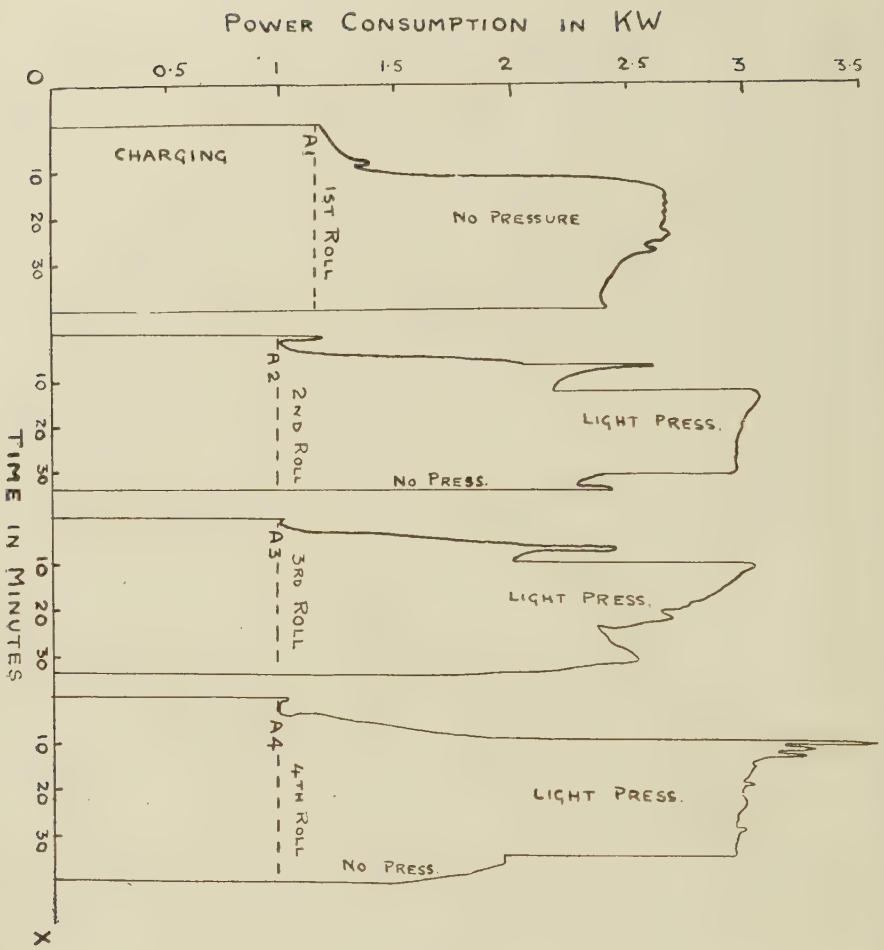

Fig. II.

POWER CONSUMPTION IN ROLLING.

these differences several important features can be seen in the diagram. The power consumption at A 1 A 2 A 3 and A 4 is that due to overcoming the inertia of motor and roller mechanism combined. We shall therefore be able to distinguish between total work done and work done on the leaf, a definite step forward. It is noticeable that in the process of charging the roller the increase in power consumption on Roll 1 is small, but that as soon as rolling proper begins, even without pressure, the first few minutes see a great increase in work done. This is a point which will merit close attention in further experiments, because if it is a constant feature of rolling it shows that the normal friction between leaf and table, in the tacky state

which develops in the process, contributes largely to the energy consumption and hence to the rapidity or otherwise of commination of the leaf bulk. In the instances depicted here, it is evidently the main reason for power consumption and overshadows the small pressure factor added in subsequent rolls.

There is confirmatory evidence for the drop in pressure that was noted in ordinary pressure measurements, but the momentary oscillations are very much damped down when power and not simply pressure is considered; this gives a technical advantage to power measurements. The release of pressure is clearly visible except in Roll 3.

These diagrams have a value beyond the purely pictorial aspect that is evident on casual scrutiny. The area bounded by the trace and the zero power ordinate OX is an exact measure of work done when corrected for motor efficiency. Consequently, by determining the areas and converting into the appropriate standards, the work done on the leaf for each roll can be estimated. Measurements are made on that portion of the area which lies above the power ordinate for the machinery alone, *i.e.*, above A_1 A_2 A_3 and A_4 respectively.

For purposes of illustration, in the absence of details of motor efficiency the crude areas have been used to compile the following Table 5.

TABLE V.

Data of Roller Performance.

Roll	Leaf fed lb.	Dhool produced lb.	Dhool per cent	Kilo watt minutes				
				Total work	Work on mechanism	Work done on leaf	Work per 100 lb. leaf	Work per lb. dhool
1	350	46	13·1	88·6	49·2	39·4	11·25	·856
2	290	49	13·7	83·0	40·8	42·2	14·55	·862
3	239	39	11·1	81·4	37·0	44·4	18·60	1·140
4	197	50	14·3	98·4	40·0	58·4	29·60	1·170
B.B. loss.	147	—	42·0 5·8					

The most informative data are in the two last columns. As rolling proceeds an increase of work done per 100 lb. of leaf fed is needed. In a similar though not strictly identical fashion the later dhools absorb more power per unit in their separation. At the moment no more particular deduction can be drawn from the work per dhool figure. It would be premature to try and interpret the similarity between the values for 1 and 2 or for 3 and 4.

There is nothing startling in these findings; they are quite according to the expectation of any competent observer, but what is of note is that what has previously been a matter of incomplete inference is now capable of objective demonstration and measurement. This fact and the additional one that the method gives a way of measuring a cumulative and continuous operation by continuous means opens up the possibility of disentangling the various factors which come into play in the ordinary rolling process.

Application of the Power Method:—Although this report is based on work carried out in the calendar year it will be convenient, in order to get some perspective of where this work is leading, to conclude by pointing out two or three lines of inquiry which are now brought within the scope of accurate inquiry.

(1) Having evolved a standard of measurement it will be possible, with modified apparatus, to ensure with added reliance the satisfactory comparability of small experimental rollers in manufacturing experimental leaf.

(2) The question of the relationship of experimental manufacture on small rollers to ordinary factory manufacture can now be more satisfactorily approached.

(3) A criterion is now possible by which to judge the performance of different types of roller, and different rolling programmes both with regard to pressure and speed. Under standardised conditions of pressure and speed, the effect of number and type of batten is directly measurable.

(4) A fresh viewpoint is offered to the intricate problem of roller temperatures. Part of the heating in rollers is due to the evolution of chemical heat liberated during the oxidation processes in fermentation; part is due to mechanical heat, particularly when pressure is applied. It may be possible to evolve some equation which will indicate the latter in terms of power used, and the relative importance of these two heat components at different stages of manufacture will then be capable of investigation.

During the course of the year, experiments on the effect of mechanical winnowing have been carried out, the results of which will be reported later.

Finally, it is a pleasure to acknowledge the large amount of time and help freely accorded, at every stage in these manufacturing experiments, by Mr. F. J. Whitehead.

T. EDEN,
Agricultural Chemist.

ANNUAL REPORT OF THE SMALL-HOLDINGS OFFICER FOR 1933.

Meetings and Lectures:—During the period under review seventeen meetings of Small-Holders were held, four of these being held in a part of Yati-Nuwara which also comes within my working area. They are all holdings situated in the villages that border the Colombo-Kandy main road. As frequent visits are made to Nawalapitiya a meeting was also held at Ulapane to enable me to work some of those areas I pass through. The other meetings were all held in Uda-Palata and Uda-Nuwara.

These meetings are held with the object of impressing upon the Small-Holder the usefulness of cultivating green manures and cover crops such as *Dadap, Gliricidia, Boga, Tephrosia Vogelli,* etc. on their holdings. At the same time improved methods of draining and pruning are advocated such as the "Lock and Step" drain, the maintenance and construction of which is cheap and "Rim lung" pruning, the adoption of which reduces the losses due to dieback after pruning and helps quicker recovery. Great assistance has been rendered by the Village Minor Headmen in organising these meetings. The average attendance has always been over 15 Small-Holders.

Demonstration Work:—Meetings are followed by demonstration work which has been carried out on 53 holdings during the period under review.

When Holdings are visited for demonstration work personal supervision and assistance is rendered. Considerable time is once again spent at these demonstrations trying to convince the Small-Holder of the usefulness of adopting the methods advocated. These personal talks and meetings greatly help the progress of work.

The attendance at these demonstrations depend mainly on where the holding on which the demonstration work is carried out is situated. If the land is situated by the side of a cart road or Gansabawa road, one finds interested people stopping to see what is happening while curiosity attracts others. Questions are asked and the new methods discussed and by these means the new methods are adopted. At times hired labour is employed at these demonstrations and the labourer himself may happen to be an owner of a holding when he in turn adopts the new methods. It is usually the owner and a labourer or two with the Village Headman that are present at these demonstrations. Different holdings are visited for demonstration work with the different owners as individual attention is best for good progress.

To get together Small-holders for the purpose of demonstration work is somewhat difficult but if the Institute had its own demonstration plot Small-Holders could be invited to inspect and learn the new and different works.

The villages mentioned below have been visited and re-visted every month or every other month so far as my travelling vote permitted me. During these visits inspections are made for the purpose of finding out what progress has taken place with the different works, also for the purpose of rendering further assistance in these matters. Every endeavour is made to meet as many Small-Holders as I can and to instruct and help them to adopt better and more systematic methods of working their holdings.

The progress achieved in the different villages has been very satisfactory, considering the financial position of many of the Small-Holders owing to the market value for tea which hardly leaves anyone with any working profits.

The work however, has been satisfactory as I find that the Small-Holders I have been able to persuade to adopt the more improved methods for the good maintenance of their holdings have done everything I have recommended. Drains have been cut and green manures established as the weather and circumstances permitted. In every village to which I have been I find there are two or three Small-Holders adopting the new methods advocated. Results are slow but they will in time to come form good demonstration blocks in these different villages.

There are 57 holdings in the undermentioned villages where the Small-Holders are adopting the new methods. With more frequent visits and with the improving conditions of the tea market I expect better progress and quicker results.

Uda-Palata

Angammana.
Attabage-Udagama.
Bowella.
Dunukeulle
Hindagalla
Kirinde
Harakolla
Kalugommuwe
Langundeniya
Naranvita
Doluwe
Thelihunna

Udu-Nuwara

Walgawwagode
Kiribathkumbure
Pitamatalawwe
Menikdewella

Yati-Nuwara

Aludeniya
Ambanwella
Bambaradeniya
Ganhata
Geli-Oya
Gadahadeniya
Hendeniya
Imbuldeniya
Kossine
Langanuwa
Lankatillcke
Talawatura
Wellambodde
Wattapolla
Wegiriya

Nawalapitiya

Mr. C. E. Kelaart's property.

The holdings visited during my inspections total 108, of these 57 owners are doing good work.

Green Manures:—The advocation of green manures had been accompanied by the supply of seed from the Institute at cost price and many have taken this opportunity of buying the seed and establishing more green manures. Seed and green manure cuttings have in many instances been supplied free by Superintendents of Estates. There has also been willing co-operation on the part of Estate Superintendents who have afforded every assistance to the Small-Holders who seek their advice.

Tea Restriction:—There has been a considerable trade in tea coupons; about 60 per cent. of Small-Holders having sold their coupons. The reasons in my opinion are: (1) The price of green leaf had been bad for many years. Before the issuing of coupons there was a rise in the tea market and then a sudden drop. Just when the coupons were issued the price for these were 36 cents per pound and the Small-Holder took no risk but sold them.

(2). There were rumours that inspections would be made of all land registered for the issue of coupons. Having no capital to weed and drain at the time when applications for coupons were made, the earliest opportunity was taken to sell the coupons when obtained and the money was spent on weeding, draining, etc.

(3). Creditors pressed their debtors for the repayment of loans and overdue interest.

(4). Overdue fields were pruned and coupons sold.

(5). Many sold their coupons with the first issue as they were under the impression that this would be a monthly occurrence.

(6). Many sold their coupons as they are unable to dispose of their crop.

(7). Another reason why there is the sale of coupons is that factory owners are unable to pay more than 10 and 11 cents per pound of green leaf just now.

(8). The majority of Small-Holders have lost faith in the bought leaf factory owner and the middleman, thus he is afraid to hand his coupon to either. The middleman has disappeared to a great degree as the Small-Holders prefer dealing direct with the factory owner.

There should be legislation to the effect that Small-Holdings must be kept in a good condition and free from weeds, as everyone could afford it just now. Whether coupons have been sold or not holdings are now being

freed of their thick growth of weeds, that is holders are utilizing a portion of the proceeds from the sale of coupons for the improvement of their holdings.

General:—We have still to see what restriction is ultimately going to mean to the Small-Holder, but I doubt very much whether he will suffer harm.

Village Agricultural Associations have been formed very recently and I think through these Associations much work could be done for the improvement of the condition of the Small-Holder and his holdings.

A party of 24 Small-Holders visited St. Coombs in September last year. They were shown round the different experimental fields and the laboratory. This convinced those who visited of the benefits which could be derived if they only adopted the new methods advocated on their holdings as the majority of Small-Holders take in more with the eye than the ear.

I must once more tender my thanks to the Chief and Minor Headmen of Uda-Palata, Udu-Nuwara and Yati-Nuwara, also to all Estate Superintendents for their co-operation in my work.

R. L. ILLANKOON,

Small-Holdings Officer.

Meteorological Observations 1933.

St. Coombs.

	Temperature				Mean Relative Humidity	Rainfall Inches	No. of Rainy days	Hours of Sunshine
	Mean. Max.	Mean. Min.	Adopted Mean.	Mean on Grass				
								hrs. mts.
January	70·7	59·1	64·9	57·1	79	11·15	24	101·6
February	75·2	54·5	64·9	49·9	64	0·49	8	211·57
March	77·0	55·0	66·0	49·7	67	3·60	13	256·44
April	77·1	57·1	67·1	53·6	78	6·82	15	231·58
May	71·5	59·3	65·4	57·7	85	36·44	30	79·9
June	69·2	59·6	64·4	58·4	77	9·54	27	109·31
July	67·9	59·4	63·7	58·4	87	16·41	30	76·35
August	70·7	58·7	64·7	57·4	85	12·80	25	109·36
September	69·4	58·9	64·2	57·6	85	12·96	25	102·58
October	69·7	58·0	63·9	56·3	85	16·00	27	121·51
November	72·9	56·3	64·6	52·5	79	6·17	18	160·27
December	73·0	54·4	63·7	49·4	71	1·36	11	207·15
Annual	72·0	57·5	64·8	54·8	79	133·74	253	1769·07
			Means				Totals	

THE TEA RESEARCH INSTITUTE OF CEYLON.

BALANCE SHEET AS AT 31ST DECEMBER, 1933.

LIABILITIES.	Rs. Cts.	Rs. Cts.
GOVERNMENT LOAN :—		
On Mortgage @ 6% per annum	1,000,000 00	
Less Repayments to date ...	102,746·41	897,253·59
RESERVE FOR SPECIFIC LIABILITIES		36,600·10
EXCESS OF ASSETS OVER LIABILITIES :—		
Appropriated :		
For Fixed Property Expenditure	87,050·00	
Already Expended on Fixed Property	718,112 84	
	805,162·84	
Unappropriated :		
Represented by Working Funds	34,015·55	839,178·39
	Rs. 1,773,032·08	

ASSETS.	Rs. Cts	Rs. Cts.
FIXED ASSETS :—		
Property ...	754,469·98	
Buildings and Lines ...	727,483·21	
Furniture and Equipment	49,080·04	
Machinery and Tools ...	70,497·41	
Experimental Machinery ...	11,185·63	
Motor Car ...	2,650·16	1,615,366·43
APPROPRIATED FUNDS :—		
For Repayment of Government Loan and payment of Interest	19,500·00	
For Additional Buildings ...	45,000·00	
,, Replacement of Fixed Assets	28,000·00	
,, Development of Immature Areas ...	12,000·00	
,, Staff Furlough ...	17,100 10	
,, Replacement of Car ...	2,050·00	123,650·10
WORKING FUNDS :—		
Cash	5,762·19	
Sundry Debtors ...	23,605·28	
Stocks	12,240·52	
	41,607·99	
Less Immediate Liabilities	7,592·44	34,015·55
		Rs. 1,773,032·08

We have audited the books of the Institute kept by the Planters' Association at Kandy in which are incorporated the Estate Returns. We have not audited the Estate Accounts.

The allocations of Capital Expenditure, and of Research Revenue Expenditure as made by the Director and sanctioned by the Chairman have been accepted by us.

Subject to the foregoing, we certify that in our opinion the above Balance Sheet, together with our Report of 22nd March, 1934. addressed to the Chairman, presents a true and correct view of the state of the Institute's affairs according to the information and explanations afforded to us, and as shown by the books of the Institute kept at Kandy.

(Sgd.) FORD, RHODES, THORNTON & Co., *Auditors*
Chartered Accountants.

Colombo, 22nd March, 1934.

THE TEA RESEARCH INSTITUTE OF CEYLON.

ESTATE WORKING ACCOUNT FOR THE YEAR ENDED 31ST DECEMBER, 1933.

EXPENDITURE.	Rs. Cts.	Rs. Cts.	INCOME.		Rs. Cts.
To Estate Revenue Expenditure	62,373·94		By Tea Sales	132,292 lbs.	
,, Charges Export Duty Etc.	5,743·16	68,117·10	,, do Inferior	2,180 ,,	... 98,170·86
,, Balance		30,053·76			
		Rs. 98,170·86			Rs. 98,170·86

INCOME AND EXPENDITURE STATEMENT AS AT 31ST DECEMBER, 1933.

To Administration of the Board :—	Rs. Cts.	Rs. Cts.	By Balance from Estate Working Account ...	Rs. Cts.
Planters' Association of Ceylon	4,800·00		,, Tea Cess	304,939·63
Travelling Expenses of Board	2,102·16		,, Interest	1,735·78
Postages ...	259·37		,, Rent of Caddy	60·00
Stationery ...	515·30		,, Fees for Advisory Work	100 00
Advertising ...	18·69			
Telephone Trunk Calls etc.	245·96			
Printing ..	186·00			
Auditors' Fees and Expenses	400·73			
Contingencies, Commission etc.	263·01	8,791·22		
,, Personal Emoluments of Sc. Staff :—				
Director ...	19,229·33			
Mycologist ...	18,044·92			
Agricultural Chemist ..	14,271·77			
Biochemist ...	8,484·51			
Entomologist ...	12,453·39			
Plant Physiologist ...	9,766·94	82,250 86		
,, Laboratories :—				
Junior Staff Salaries ...	22,577·68			
Laboratory Peons ...	1,574·12			
Nettle Grub ..	844 71			
Conference Fees ...	340·14			
Equipment ...	2,644·49			
Furniture and Alterations	133·89			
Library ...	954·00			
Publications ...	Cr. 2,447·02	26,622·01		
Carried forward :—		Rs. 117,664·09	Carried forward :—	Rs. 336,889·17

INCOME AND EXPENDITURE STATEMENT AS AT 31ST DECEMBER, 1933.—(*Contd.*)

	Rs. Cts.	Rs. Cts.		Rs. Cts.
Brought forward :—		117,664·09	Brought forward :—	336,889·17
,, Small Holdings & Working Expenses ...		3,530·53		
,, Field & Factory Experiments :—				
Agricultural Chemist ...	1,327·19			
Plant Physiologist ...	2,409·50			
Factory Experiments ...	973·90	4,710·59		
To Laboratory Offices :—				
Clerks	2,278·91			
Peon	362·00			
Stationery	713·16			
Postages	347·95			
Telephone Trunk Calls & Telegrams	110·51	3,812·53		
,, Travelling of Staff :—				
Officers' Expenses ...	1,043·75			
Insurance of Car ...	173·34			
Driver's Wages ...	962·74			
Driver's Batta ...	151·35			
Running Expenses ...	1,788·15	4,119·33		
,, Maintenance of Buildings :—				
Laboratory ...	26·03			
Six Senior Staff Bungalows	610·52			
Six Junior Staff Bungalows	261·75			
Two Clerks Bungalows ...	72·75			
Miscellaneous Buildings ...	186·54	1,157·59		
,, Items Shared with Estate :—				
Electric Power ...	3,985·22			
Engine Room Staff ...	686·69			
Mechanic ...	45·50			
Telephone Operators ...	664·00			
Telephone Rent and Maintenance of Lines ...	380·94			
Roads ...	4,190·40			
Sanitation	643·22			
1/5th Share Superintendent's Salary	2,058·37			
do Furlough and Passage Reserve ...	438·00			
Tappal Lorry and Book Fees	207·50	13,299·84		
Carried forward :—		Rs. 148,294·50	Carried forward :—	Rs. 336,889·17

INCOME AND EXPENDITURE STATEMENT AS AT 31ST DECEMBER, 1933.—(*Contd.*)

	... ... Rs. Cts.	Rs. Cts
Brought forward :—		148,294·50
,, Upkeep of Grounds :—		
Labour	487·73	
General Expenditure ...	164·16	651·89
,, Contingencies :—		
Incidentals ...	93·64	
Ceylon Planters' Provident Society	4,437·74	
Junior Sc. Staff Provident Fund	1,216·90	
Clerks & Sub. Staff do	299·77	
Passages ..	1,822·32	
Ceylon Nursing Association	65·00	
Dispenser's Sub. Staff Fees etc.	59·50	
Insurances	1,689·96	
Subscription to Imperial and Mycological Institutes	—	
Caretakers Snr. Staff Bungalows	364·60	10,049·43
To Government of Ceylon Loan Interest Account		54,870·75
,, Depreciation Account		28,000·00
,, Balance (to Surplus Account)		95,022·60
	Rs.	336,889·17

	Rs. Cts.
Brought forward :—	336,889 17
	Rs. 336,889 17

THE TEA RESEARCH INSTITUTE OF CEYLON.

SURPLUS ACCOUNT AS AT 31ST DECEMBER, 1933.

		Rs. Cts.		Rs. Cts.
To Difference in Exchange		128·14	By Balance—31st December, 1932. ...	727,546·96
,, Reserves :—			,, Furlough Reserves at 31st December, 1932, written back	11,878·26
For Repayment of Government Loan ...	19,500·00		,, Excess of Revenue over Expenditure for 1933	95,022·60
,, Additional Buildings ...	45,000·00		,, Amount transferred from Loan Account ...	13,458·81
,, Development of Immature Areas ...	12,000·00			
,, Staff Furlough ...	17,100·10			
,, Replacement of Car	2,050·00	95,650·10		
,, Balance carried forward ...		752,128·39		
		Rs. 847,906·63		Rs. 847,906·63

	Rs. Cts.	Rs. Cts.
By Balance		Rs. 752,128·39
Expended on Property	718,112·84	
Working Funds ...	34,015·55	
	Rs. 752,128·39	

LOAN ACCOUNT.

	Rs. Cts.			Rs. Cts.	Rs. Cts.
To Government of Ceylon	1,000,000·00	By Repayments :—			
		1st Instalment	1929 ...	18,227·00	
		2nd ,,	1930 ...	19,320·72	
		3rd ,,	1931 ...	20,479·00	
		4th ,,	1932 ...	21,708·60	
		5th ,,	1933 ...	23,011·09	102,746·41
		,, Balance due			897,253·59
	Rs. 1,000,000·00				Rs. 1,000,000·00

St Coombs Estate Tea Sales
1933